SCIENCE

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THE AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS

INTRODUCTORY ADDRESS

IN calling this meeting to order, I wish first to say a few words about the services performed by the committee on organization —and I am sure none of them will think it invidious if I refer particularly to the work of the secretary, Professor Lovejoy, who has borne the heat and labor of the day more than any one else. All of its members are busy men and the work they have done is a labor of love. It is but fair to them that it should be known to all that their labors, continued for over a year, have been singularly free from a disposition on the part of any one to push a particular scheme or ride a particular hobby. If any one, perchance, has come here to-day with a fear that something is to be sprung upon the meeting, or that the committee has, as the saying goes, something up its sleeve, pray let him disabuse himself of the idea. The committee has tried to do nothing more than had to be done to bring together a representative body, without reference to factions or sections; to get matters into shape to facilitate discussion and economize time.

Doubtless we have made mistakes. But they are only such as are incident to getting a large enterprise under way, especially considering the lack of authoritative precedents to follow, and the lack of such clerical and other machinery as the organization itself will bring into being. The committee found itself between the Scylla of doing nothing definite and the Charybdis of doing so much as to forestall action that

ought to be taken only by the organization itself. So it thought its main effort should be to collect representative opinions and to secure the adhesion of a body of men large enough to represent different types of institutions, different lines of work and different sections of the country. Each member of the committee was asked to prepare two lists of names; one of men of full professorial rank in his own institution, and the other of men (of like grade) in his own subject, irrespective of institutional connection. Then these two lists were combined so as to include names found on either. To simplify the work, invitations were not sent to men in institutions represented by less than five names.

You will readily see that there was no available way for standardizing the basis of selection employed by the more than thirty men on the committee. Hence it is not only probable that there are omissions of teachers who should have been asked, but that there is inequity of distribution among different institutions and branches of learning. But I am sure that there is no inequality which can not readily be straightened out in the workings of the association itself. It should also be stated that the draft of a constitution to be submitted has not, for lack of time and because of the wide geographical distribution of the men on the committee, been authorized by the committee as a whole. This is hardly to be regretted for it reserves for each member complete freedom of action, and emphasizes the point that the chief object of its preparation is not to supply an ideal or final draft, but a definite basis for discussions to bring out and register the will of the meeting. At the same time it should be said that the draft does not represent so much the wishes of the members of the subcommittee personally as the preponderant drift of the opinions expressed in letters in reply to the circulars sent out.

As much as this I should probably have felt like saying in any case. But the committee has asked me also to speak upon the reasons for calling this assembly together. What is the proposed association for? Any proposal to increase the existing number of associations, meetings, etc., assumes a serious responsibility. The burden of proof is upon it.

We are in a period of intense and rapid growth of higher education. No minister of public education controls the growth; there is no common educational legislature to discuss and decide its proper course; no single tribunal to which moot questions may be brought. There are not even long-established traditions to guide the expansive growth. Whatever unity is found is due to the pressure of like needs, the influence of institutional imitation and rivalry, and to informal exchange of experience and ideas. These methods have accomplished great things. Within almost a single generation our higher education has undergone a transformation amounting to a revolution. And I venture to say that, in spite of the deficiencies we so freely deplore, no country has at any time accomplished more in the same number of years.

But have we not come to a time when more can be achieved by taking thought together? In the future, as in the past, progress will depend upon local efforts in response to local needs and resources. We have the advantages as well as the disadvantages of the lack of the European system of centralized control. So much the more reason for the existence of a central body of teachers, which, lacking official and administrative power, will express the opinion of the profession where it exists and foster its formation where it does not exist. I am a great believer in the power

of public opinion. In this country nothing stands against it. But to act, it must exist. To act wisely, it must be intelligently formed. To be intelligently formed, it must be the result of deliberate inquiry and discussion. It can not be developed in corners here and there; it can not be the voice of a few, however wise. It must be formed democratically; that is, cooperatively. All interests, however humble, must be heard; inquiry and conference must glean all the experiences available; decision must be based upon mutual consultation.

The need of a voluntary organization is the greater because of certain facts in the history of the American university. The rapid growth already referred to has occurred under a machinery designed for very different conditions. We are doing our educational work under methods of control developed decades ago, before anything like the existing type of university was thought of. Our official methods of fixing fundamental educational polity as well as of recruiting, appointing, promoting and dismissing teachers, are an inheritance from bygone conditions. Their lack of adaptation to the present situation is due not to sinister intent, but to the fact that they are a heritage from colonial days and provincial habits. The wonder is not that there is so much restlessness and friction, but that there is not more. A system inherently absurd in the present situation has been made workable because of the reasonableness and good will of the governors on one side and, even more, of the governed on the other.

All the more need, then, of ascertaining, precipitating in discussions and crystallizing in conclusions the educational experiences and aspirations of the scholars of the country. I confess myself unable to understand the temper of mind which anticipates the danger of what some term trades-unionism or of interference with constituted administrative authorities as a result of the formation of this organization. As to the latter: I know of few teachers who wish additional administrative work: most would be glad of relief from duties that do not seem exactly significant and that are time-consuming. But it is not expedient, in view of the trust committed to us, to maintain a state of affairs which makes difficult or impossible among college teachers the formation and expression of a public opinion based on ascertained facts. I can not imagine that existing authorities will not welcome the results of inquiries and discussion carried on by a truly representative body of teachers. To think otherwise is to dishonor both ourselves and them. The only thing which is undignified and intolerable is that teachers, individually or collectively, should indulge in carping criticism of boards of trustees when they have not thought it worth while to cultivate an enlightened educational polity among themselves nor found the means for making themselves heard. If we do not like the present situation we have nobody but ourselves to blame.

Let me add that I can think of nothing so well calculated to lift discussions of educational defects and possibilities from the plane of emotion to that of intelligence as the existence of a truly representative body of professors. The best way to put educational principles where they belong—in the atmosphere of scientific discussion—is to disentangle them from the local circumstances with which they so easily get bound up in a given institution. So to free them is already to have taken a step in their generalization. The very moment we free our perplexities from their local setting they perforce fall into a truer perspective. Passion, prejudice, partisanship, cowardice and truculence alike tend to be eliminated,

and impartial and objective considerations to come to the front. The very existence of a recognized free forum of discussion with one's fellows gathered from all parts of the country will make for sanity and steadiness quite as much as for courage.

The fear that a "trade unionism" of spirit will be cultivated is ungrounded. I have great respect for trade unions and what they accomplish. Many of the questions which have been suggested for consideration by this body have their economic aspect. Since economic conditions seriously affect the efficiency and scope of our educational work, such topics are surely legitimate ones for inquiry and report. But the term trades unionism has been used to suggest a fear that we are likely to subordinate our proper educational activities to selfish and monetary considerations. I have never heard any one suggest such a danger for the American Bar Association or the American Medical Association. Pray, are the aims of college teachers less elevated? Or is it that our position is so much less assured that any organized association must take on such a color? Are we animated by a narrower or more sordid spirit? Is there anything in the history of our body which indicates materialism of spirit, or indeed anything but an idealism which lends itself to being imposed upon rather than to propaganda in behalf of narrow trade interests? Ladies and gentlemen, I resent such insinuations. I can not believe that we are fallen so low that association for the purpose of careful investigation and discussion of common educational interests can be interpreted by any right-minded person as a rebellious and mercenary organization. If we have so fallen, something immensely more radical than the formation of this organization is the indicated remedy.

A word upon the subject of the relation of the association to academic freedom may be in place, especially as it has been mistakenly stated in the public prints that this matter is the chief cause of the formation of this organization. I do not know any college teacher who does not believe that cases of infringement may arise. I do not know any who does not hold that such infringement, when it occurs, is an attack upon the integrity of our calling. But such cases are too rare to demand or even suggest the formation of an association like this. Existing learned societies are already disposed to deal with cases of infringement as they may come to light, and in my opinion it is a matter of detail rather than of principle whether they should be dealt with by such special bodies or by a more inclusive body like this. In any case, I am confident that the topic can not be more than an incident of the activities of the association in developing professional standards, standards which will be quite as scrupulous regarding the obligations imposed by freedom as jealous for the freedom itself. The existence of publicly recognized and enforced standards would tend almost automatically to protect the freedom of the individual and to secure institutions against its abuse.

In conclusion, let me say that proposing such an association as this is to my mind but proposing to apply to our common calling the standards and ideals to which we have been trained, each in his special line of work. In his own branch, each of us recognizes how little he can do by himself; how dependent his efforts are upon cooperation and reinforcement by the work of a multitude of others. Let us cultivate a like social sense of the wide educational interests we have in common; of our dependence upon one another as institutions and as teachers. In his own specialty, each of us recognizes the need of careful study of facts before coming to a conclu-

sion. Shall we not require of ourselves a similar scientific spirit as we try to settle educational questions? A more intense consciousness of our common vocation, our common object and common destiny; and a more resolute desire to apply the methods of science, methods of inquiry and publicity, to our work in teaching—these are the things which call for the existence of organized effort. Surely we shall have the judgment, the courage and the self-sacrifice commensurate with reverence for our calling, which is none other than the discovery and diffusion of truth. No one has any illusions about what can be immediately accomplished. Let us therefore arm ourselves with patience and endurance in view of remoter issues. No one underestimates the practical difficulties in our way. But arming ourselves with the good will and mutual confidence our profession exacts of us, we shall go forward and overcome them.

JOHN DEWEY

ORGANIZATION OF THE AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS

THE meeting called for the purpose of organizing this association was held in the auditorium of the Chemists' Club, New York City, on the afternoon and evening of Friday, January 1, and the morning of Saturday, January 2, 1915. Over 250 were in attendance in the course of the three sessions. Professor John Dewey, of Columbia University, called the meeting to order and delivered an introductory address upon the purpose and possibilities of such an association, as conceived by the committee on organization, of which he had served as chairman. Nominations for the chairmanship of the meeting being called for, Professor Dewey was nominated and elected permanent chairman, and Professor Overstreet, of the College of the City of New York, recording secretary. Addresses in support of a motion to proceed to the organization of the association were made by Professors Guthe of Michigan, Thilly of Cornell, West of Princeton, Howard of Nebraska; and a letter from Professor Gildersleeve of Johns Hopkins was read. The motion was unanimously carried.

The consideration of the draft of a constitution submitted by the committee on organization was then begun. This took up most of the afternoon and evening and a part of the morning session. In order that the alternative plans of organization might receive full discussion, the meeting, in most cases, voted upon the principles involved in the several articles, rather than upon the language of the instrument. A committee was appointed to draw up the text of a provisional constitution in conformity with the action taken by the meeting, this draft to be submitted for ratification at the next annual meeting. The decisions of the gathering with respect to the principal features of the plan of organization were as follows:

1. *Name.*—After the consideration of a number of alternatives, it was voted that the name of the society be "The American Association of University Professors."

2. *Eligibility for Membership.*—It was voted that any person may be nominated for membership who holds and for ten years has held a teaching or research position in any one, or more than one, American university or college, or in a professional school of similar grade; provided, that no person not having teaching or research for his principal occupation, and no administrative officer not giving a substantial amount of instruction, shall be eligible. Nominations for membership may be made to the council by any three members of the association; nominations thus made, and ap-

proved by the council, will be voted upon at annual meetings, a two-thirds vote being required to elect. For the guidance of the council in acting upon nominations, it was voted, upon motion of Professor Janeway, that "it is the sense of this meeting that the association shall be composed of college and university teachers of recognized scholarship or scientific productivity." It was voted that all persons to whom invitations to attend the first meeting had been sent by the committee on organization may become members of the association by signifying to the secretary their desire to do so, within three months from January 1, provided that they hold positions in institutions of collegiate or university grade and that their duties are not solely administrative.

3. *Officers.*—It was voted that the officers of the association shall be a president, a vice-president, a secretary, a treasurer, and a council consisting of the foregoing and 30 additional members. The president and vice-president are to be elected by a majority vote for a term of one year; the secretary and treasurer are to hold office for three years. Thirty members of the council are to be elected for the first year, lots being drawn to determine which shall hold office for one, for two and for three years, respectively; at each subsequent annual meeting ten members of the council are to be elected by a plurality vote to hold office for three years. The council has power to arrange the program for the annual meeting and to appoint committees to investigate and report upon subjects germane to the purposes of the association. During the year 1915 the council is authorized to spend such sums out of the funds of the association as may be necessary for the business of the year, and also to defray expenses incurred in the organization of the association.

4. *Local Societies.*—The question of the formation of local societies was discussed at some length. Although the sentiment of the meeting was apparently unfavorable to this plan, the council was authorized to take the matter under consideration and to report at the next meeting upon the desirability of the formation of institutional or territorial chapters.

5. *Dues.*—The annual dues were fixed at $2.00.

The greater part of the concluding session was given up to the discussion of topics to be placed upon the program of the association for the ensuing year. The secretary of the committee on organization read a number of interestingly diverse topics suggested in writing by members not present. A paper by Professor Royce of Harvard University on "The Case of Middlebury College and the Carnegie Foundation" was read, proposing as a suitable subject the question of "the limits of standardization" in educational methods and organization, and the "standardizing" activities of extra-academic corporations. This subject, and the two following, were finally recommended to the council as the topics most suitable for examination by special committees and report during the coming year: methods of appointment and promotion; the manner in which the university teaching profession is at present recruited, with especial reference to the existing system of graduate fellowships and scholarships. Upon Professor Seligman's motion the council was also instructed to attempt to bring about a merging in a new committee of the committees already created by the economic, political science and sociological associations to deal with the subject of academic freedom, the joint committee to be authorized to investigate the subject in behalf of this association and to report at the next annual meeting.

The committee appointed to present nominations for officers for the year 1915 reported, through its chairman, Professor Tatlock, of Michigan, that in the time at its disposal it had not been able to make sufficiently well-considered nominations for more than twenty-eight places on the council. Professor H. C. Warren, of Princeton University, who was nominated for the secretaryship, declined the nomination. The following were elected: President: John Dewey, Columbia University, education; Vice-president: J. M. Coulter, University of Chicago, botany; Treasurer: J. C. Rolfe, University of Pennsylvania, Latin. Members of the council: M. Bloomfield, Hopkins, Sanskrit; E. Capps, Princeton, Greek; A. P. Carman, Illinois, physics; A. S. Cross, Yale, English; G. Dock, Washington University, St. Louis, medicine; H. D. Foster, Dartmouth, history; E. C. Franklin, Stanford, chemistry; C. M. Gayley, California, English; R. G. Harrison, Yale, zoology; W. H. Hobbs, Michigan, geology; A. R. Hohlfeld, Wisconsin, German; G. E. Howard, Nebraska, history; A. O. Lovejoy, Hopkins, philosophy; W. T. Magruder, Ohio, engineering; J. L. Meriam, Missouri, education; A. A. Michelson, Chicago, physics; W. B. Munro, Harvard, political science; A. A. Noyes, Massachusetts Institute of Technology, chemistry; E. C. Pickering, Harvard, astronomy; H. C. Warren, Princeton, psychology; R. Weeks, Columbia, Romance philology; H. S. White, Vassar, mathematics; J. H. Wigmore, Northwestern, law; W. F. Willcox, Cornell, economics. The officers elected were given power to fill the vacancies remaining in the council, and to elect a secretary to serve during the year; it was voted that, pending the election of a secretary, Professor Lovejoy, of Johns Hopkins University, be asked to continue to discharge the duties of that office.

Votes of thanks were extended to the Chemists' Club for their courtesies; to the Women's University Club for hospitalities to woman members of the profession in attendance at the meeting; and to the officers and members of the committee on organization. The meeting, notable in the history of the American universities and distinguished by the number of eminent scholars attending and by the interest and quality of its discussions, then adjourned.

It is perhaps advisable to put on record at this time the history of the steps, antecedent to this meeting, taken in the organization of the new association. The project was initiated by a communication signed by most of the full professors of the faculty of the Johns Hopkins University, which was sent, in the spring of 1913, to the members of the faculties of nine other universities, inviting the latter to consider the advisability of the formation of such a society, and to send delegates to an informal conference for discussion of the matter. A favorable response was received in all cases, and statements expressing a conviction of the desirability of the creation of some such professional association were drawn up and signed by members of the faculties of nearly all the universities addressed. The proposed conference was held at Baltimore on November 17, 1913; it was attended by 18 delegates from the following universities: Clark, Columbia, Cornell, Harvard, Johns Hopkins, Princeton, Wisconsin and Yale. The chairman of this conference, Professor Bloomfield, was authorized to appoint a committee on organization, representing the principal subjects of study and the principal universities. This committee, under the chairmanship of Professor Dewey, after prolonged discussion, decided that

it would not attempt to define the conditions of eligibility for membership, but that invitations to join in the formal organization of the association should be sent to persons of full professorial rank whose names appeared on the lists of distinguished specialists prepared for the committee in each of the principal subjects, provided that such professors were connected with institutions having five or more names upon these lists. Some 650 of those to whom these invitations were sent have thus far expressed their sympathy with the general purposes formulated in the circular of the committee on organization, and their purpose to adhere to the association.

In accordance with the action above reported, members of the university teaching profession who did not receive invitations to the New York meeting, and who desire to become members of the Association, are asked to signify that desire to any of their colleagues who are already charter members or who may become such during the period allowed for that purpose—the first three months of the present year.

A. O. Lovejoy,
Secretary

Johns Hopkins University

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SAFETY ENGINEERING[1]

The address which forms part of the duty each year of your successive chairmen might have for its unvarying subject the newest subdivision of the engineer's field, since each year seems to furnish a new title to our lengthening list of engineering specialists.

One of the late differentiations calls attention to the field of safety engineering, and I bring to your attention some phases of this work. This portion of the field of engineering can not be said to involve any radically new fact or discovery, but to be rather a new grouping of interests as a result of a change of accent among the many industrial factors. In developing any engineering design there is usually a compromise between prime factors which dominate the result and minor factors which receive less accent; so also in industrial life such prime factors as production, cost, profits, expansion, etc., have heretofore received the greater accent, while the item of safety of the employee and the public, which has always been a factor in design and in management, has oftentimes been given relatively small weight. There is a rapidly growing feeling that every industry should receive its workers each day in fit condition and should return them to their homes whole and in like fit condition. Strong accent is now being given to this idea, which has resulted in a movement of very considerable momentum, and this change in accent is finding its expression in various legislation, in workmen's compensation acts, in the whole safety movement, including the work of safety engineering. Safety engineering has for its object the elimination of industrial accidents. While the result of such an accident was borne largely by the injured individual, the prevention of accidents remained more or less of a minor factor in industrial problems, but as the industry is required to carry directly a larger share of the burden resulting from accident, the problem has become one of prime importance. Each engineer, mechanical, electrical, civil and mining, is now asked to view his work from a new angle. Guards, guides and protective devices are added where it was perfectly evident these devices should have been before, but it be-

[1] Address of the vice-president and chairman of Section D of the American Association for the Advancement of Science, Philadelphia, December 31, 1914.

comes equally evident that this is a most superficial and inadequate treatment of a subject of large proportions. Statistical information is needed as to the kind of injury and the success of preventive methods. Questions arise as to the bearing on the accident problem of nationality, general intelligence, age, temperance, fatigue, housing, lighting and a multiplicity of factors usually considered as outside of the field surveyed by the engineer. The purely engineering phase of this problem has been variously estimated as forming only 10 to 25 per cent. of the whole, the problem being more largely one of mental attitude toward the thought of safety on the part of the employee and the whole organization, but the engineer's point of view seems particularly favorable as a point of departure for exploring the whole field and reducing observations to concrete changes in equipment and management. This situation has produced the safety engineer. His work is a new grouping of studies and interests. Beside his purely engineering training he is brought close to the doctor, the chemist, the social worker, the statistician, the works diplomat, the psychologist, the labor organization, legislative limitations and the lawyer. He can no longer measure all his work directly in dollars and he looks first to a column of statistics for evidence of his profits.

In the large industrial organizations the best engineers are thus engaged, under the immediate observation of the administrative head. The excellent results which have been obtained in the reduction of accidents accounts for the enthusiasm shown by industrial safety workers and organizations.

Much of this work requires only special attention to the idea of safety as an important matter, time, patience, careful observation, and the application of obvious remedies which are already in use. The great need at this point is for standardization of method. Considerable sums are expended for protective devices and constructions which are more or less inadequate and which have to be replaced as the art develops. In fire protection and electric installation, it has been found necessary to standardize equipment and a similar need is to be met in safety methods and devices. This can be brought about by preparing standard detailed specifications covering each case or by requiring the use of approved devices, the approval to be issued by some investigative body provided for the purpose. Detailed specifications are apt to be confusing and cumbersome and lack the simplicity of an approval system. The approval of safe devices must, however, be done by some body whose decisions will command general support as being the result of careful investigation.

In the mineral industries where the government has provided an investigative bureau for the specific purpose of "increasing safety," the method of granting approval to safe devices after careful investigation is already in operation and has so far provided a list of permissible explosives, approved miners' electric lamps, explosion-proof electric motors, switches, etc. Such work must of necessity move slowly, for careful investigation requires both time and money. For the general industrial field other interests are preparing to provide a means of standardizing similar to that brought about by the underwriters' fire insurance regulations.

Much of the more obvious preventative measures can be recognized by members of any and every organization, but there is a class of investigation the need of which has become quite evident which can not be expected of the usual industrial organization. Unsafe conditions are sometimes the result

of obscure physical facts, not so readily apparent, and these cases require long and careful scientific investigation with adequate laboratory facilities. An excellent illustration of this is found in the hazard of coal-mine explosions. Such a subject is one studied with difficulty by a single industrial organization and must be referred to some agency specially equipped for investigative work involving engineering, chemistry, physics and a very considerable expenditure of funds. The mining industry presents many such problems, such as the ignition of gases and various coal dusts by explosives, by electric sparks, and static discharges, and by filaments of broken electric lamps. The permissible limits of vitiation of mine air by natural gases, oxidization of timbers, dusts and fumes and by the use of internal combustion engines for haulage; these require extensive physiological as well as field and laboratory investigation. The deterioration of vital parts of equipment by fatigue, shock and corrosion demands laboratory investigation to devise means for proper protection and inspection.

Every industry will present similar safety problems that must be studied more carefully than can be expected of the unaided industrial organization. It is this phase of safety engineering that I wish to specially emphasize.

There are several agencies that can be expected to meet in various degree this need. One of the most promising is that of cooperation between a group of members of an industry and established laboratories, federal, state or educational, which laboratories may be specially fitted by men and equipment for investigating the special problem in hand. By this method the industry furnishes funds for the work while the laboratories furnish oversight, direction and experience in similar investigations. An investigation of the causes of explosion of grain dust by a group of millers and men interested in coal-dust explosions from the Federal Bureau of Mines illustrates this method. Such cooperation between industrial organizations and investigative agencies in safety problems should be greatly extended.

Investigative work in engineering laboratories connected with educational institutions have confined their attention largely to questions of efficiency. The present increased accent on problems of safety should find a similar accent in college engineering courses. Courses in engineering design and construction could without change in hours or relative weight in the whole course give increased emphasis to questions of safety by a careful selection of illustrative problems. Many organizations require that every drawing be "checked for safety" so that each construction has been criticized from this point of view and made to conform to safety standards. The standard screw and nut which has demanded the attention of generations of budding engineers in courses in drawing and design should find a worthy running mate in the standard safety hook or guard railing or belt protection. This change of emphasis should follow also into the engineering laboratories. As an illustration, it is essential for safety that gasoline locomotives used in mines or any enclosed space shall produce exhaust gases as free from carbon monoxide as possible. The size of machine that can safely be used under any given mine condition is a function of this carbon monoxide output, and a study of the performance in this regard is of quite as much importance as a study of the capacity or economy of the engine.

State engineering experiment stations in those states which have established such institutions can also be expected to take an

increasing interest in investigations of safety problems peculiar to the industries of each state. Their function has been to investigate fundamental problems relating to the efficient use of the material resources of the state, but the change of emphasis brought about by the safety movement will make safety problems of equal moment.

Another agency for the organized study of safety problems is found in the banded casualty insurance companies, who are in a peculiarly favorable position to bring an economic pressure to bear upon the industries to install standard, adequate safety devices. They propose to offer a reduction in rates where approved safety devices are installed and the underwriters' laboratories are hereafter to test approved safety devices to reduce accident risks as well as devices for reducing fire risks.

The general government is also aiding in safety engineering, as it is the province and duty of the Federal Bureau of Mines to conduct investigations with a view to increasing safety in the mining, quarrying, metallurgical and other mineral industries. This is the first government bureau to be established with the specific object of studying industrial safety in fields other than transportation. The laboratory facilities include an equipped coal mine for the study of mine explosions, chemical and physical laboratories, and the new buildings about to be commenced include mechanical and electrical laboratories.

These numerous agencies for the careful study of safety problems, which lie just behind the field of the self-evident and in the land of the more or less obscure, will each contribute something to the motley interests of the safety engineer and will help to eliminate industrial accidents.

O. P. HOOD

U. S. BUREAU OF MINES

ISOSTASY AND RADIOACTIVITY[1]

IT is the purpose of this paper to point out some apparent discrepancies between the observations of geodesists on isostasy and the inferences which some radiologists have drawn as to the great age of certain specimens of minerals. It seems well to begin by reviewing the results of isostatic investigations in order to estimate the degree of confidence to which they are entitled; and recent advances in radiology demand similar attention.

Correlation of these widely distinct researches is possible because it happens that the emission of heat by a globe whose excess temperature is due solely to radioactivity obeys Fourier's law exactly as does that emitted by a hot but radioinactive globe.

Geology as a science is conditioned by the state of the earth's interior, and our knowledge of its constitution is now advancing. So late as the foundation of this society in 1889 the Cartesian doctrine of a fluid earth enclosed in a very rigid shell a score or two of miles in thickness was held by most geologists. We now know that the globe is solid and on the whole of great rigidity and probably divisible into at least four distinct shells each more rigid than that overlying it, that the irregularities in density and structure which are so marked at the surface extend only to a depth of something like a fiftieth of the earth's radius; that open cavities or cracks may exist at depths of 20 miles and very possibly down to the level of isostatic compensation. We know too that the earth is radioactive but that the radioactivity is superficial, reaching only to a moderate though uncertain level; we also know, however, that the earth's heat is not wholly

[1] Abstract of the presidential address before the Geological Society of America, December, 1914. The full paper is too long for oral delivery and only this abstract was read at the meeting.

of radioactive origin. More information is certainly in store for us, for Mr. Michelson is now measuring the terrestrial tides in terms of the wave-length of light, while methods have been developed by which the distribution of density above the level of isostatic compensation can be studied.

Thus the future is full of hope. The rational method of attaining it is to make trial hypotheses, and to devise methods of testing them.

Laplace seems to have been the first to grasp the problem of isostasy and in 1818 he maintained that the irregularities of the earth and the causes which disturb its surface extend to but a small depth. I do not find in his memoirs any rigorous proof of this interesting anticipation. Sir John Herschel in 1833 regarded the earth as a yielding mass and considered erosion and deposition as the primum mobile of geology, but he did not pursue the subject. Archdeacon Pratt in 1858 first expressed the hypothesis of isostasy in exact terms, discussing it mathematically and adducing evidence in its favor from the geodetic survey of India.

As we all know, the enormous labor needful to prove the hypothesis from deflections of the vertical was undertaken by Mr. John F. Hayford. Mr. Helmert characterized Hayford's investigation as "truly magnificent" and called the underlying idea the Pratt-Hayford hypothesis.

Helmert himself devised a method of testing isostasy by observations on the intensity of gravity instead of deflections. His results coincide almost exactly with Hayford's and thus immensely strengthen the theory. At Helmert's suggestion also Mr. O. Hecker made many observations on the intensity of gravity at sea. These observations are indeed of inferior accuracy, but suffice to prove that isostatic compensation exists beneath the Atlantic and the Pacific as well as under the United States.

In my opinion the geodetic evidence for isostasy is so manifold and so consistent as to amount to proof. Equilibrium is nearly or quite complete at a depth of between 110 and 140 kilometers, the most probable value being near 120 kilometers.

Messrs. Hayford and Bowie have also investigated the effect of isostasy on the intensity of gravity in the United States and at selected stations in other parts of the world. This research confirms the existence of isostasy, but reveals certain anomalies due either to imperfect compensation some 120 kilometers from the surface or to irregularities in the distribution of density, or to both causes.

It is shown in my paper that the largest deflections in the United States and also the largest anomalies could be accounted for by a spherical batholith, say of peridotite, just buried beneath the surface and having a diameter of 8½ miles. Of course such a batholith would not be considered surprising by geologists. When the existence and abundance of dikes, sills and laccoliths at all accessible levels is considered, as well as the probability of their prevalence at all levels above the deepest volcanic foci, it appears that heterogeneities in the earth's outer shell are of the order of magnitude needful to account for the gravity anomalies. In short there is much evidence for the conclusion that compensation at the compensation level is very nearly complete.

If so, the mass beneath that level must be almost free from strain and can have cooled but little from its primeval temperature.

On the isostatic theory the continents stand out above the bottom of the ocean because of inferior density. This inferiority may be due to higher temperature or to voids such as joints, or to both. A third possibility is that it might be due to lithological differences, but of that there is no

evidence. The sub-continental temperature is comparatively high; for the thermometric gradient shows that at the level of average sea bottom the rocks below the continents have a temperature of about 100°, while at the bottom of the sea the thermometer stands near zero. As for crushing and jointing, recent experiments in my laboratory show that the volume of a brittle substance such as sulphur, confined in a brass tube, may be increased to the extent of more than six per cent. by bending the tube. There can be no question that rocks would behave in much the same way under such confinement as that to which deep-seated rocks are subject.

If the average subcontinental mass down to the compensation level had 3 per cent. more voids than the sub-oceanic mass, this would account for the present mean elevation of the land. The same result would follow if the average temperature under the continents were 40° higher than under the ocean. Or again, the combination of 20° excess of temperature and 1½ per cent. excess of voids would account for the continents.

If the areas occupied by the continents were originally bounded by the same level surface as the ocean bottoms, but possessed a smaller conductivity, so that they cooled more slowly, then it can be shown that the earth would constitute an imperfect heat engine and that abundant energy would be available for crumpling and crushing of the rocks or for the elevation of the continents.

Passing now to the recent developments of radiology, that wonderful branch of physics has very recently developed fresh surprises. Rutherford has put forward a nuclear theory of the atom, and van den Broek has shown that the place of an element in the periodic table is determined not by its atomic weight, but by the number of positive electric charges carried by the nucleus. This number of charges is known as the atomic number.

Now comes the astounding feature of the subject. It has been definitely discovered by Mr. Soddy, Sir Ernest Rutherford and others that a single atomic number may be borne by each of several substances which may have different atomic weights and, in the case of radioactive substances, different stabilities, but which are inseparable by ordinary chemical or physical properties. They display the same chemical reactions, the same electrochemical behavior, the same spectrum, the same volatility. It would appear, according to Rutherford, that the charge on the nucleus is the fundamental constant which determines the physical and chemical properties of the atom. Soddy calls the members of a group of elements bearing a single atomic number and occupying therefore a single place in the periodic table "isotopes."

So far as lead is concerned, this revolutionary doctrine has been authoritatively confirmed by T. W. Richards, who actually finds the atomic weight of lead from uraninite deposits unmistakably lower than that of ordinary lead.

The discovery of isotopism sufficiently explains the great discrepancies in the ages of minerals as computed from the uranium-helium ratio and the uranium-lead ratio. These ratios also no longer seem adapted to age determinations. It seems very possible, however, that the growing knowledge of atomic structure may eventually lead to trustworthy methods of age determination from radioactive phenomena; but in the meantime other methods must be resorted to.

If the earth has cooled externally from a high temperature, there must be a certain level at which the temperature of the rock most closely approaches the melting point at the prevailing pressure. This may

be called the eutectic level because the additional temperature necessary to fusion would there be a minimum. The question then arises what relation may be supposed to exist between the eutectic level and the level of compensation.

In computing the temperature distribution of a cooling globe which owes a part of its heat to compression, or to initial temperature, and another part to radioactivity, it is necessary to proceed by trial and error, or to test various assumptions and consider which best fits the facts. I have assumed various ages and computed other conditions corresponding to the actual heat emission of the globe. These other conditions are the depth of the eutectic level, the thickness of the radioactive shell (supposed uniform) and the proportion of the surface gradient due to radioactivity. Two cases are of special interest, the assumed ages being 68 million years and 1,314 million years.

For the lower age the eutectic level is at a depth of 121 kilometers, and thus coincides with Hayford's compensation level, the radioactive layer is 2.58 kilometers thick and radioactivity supplies $\frac{1}{7}$ of the surface gradient or of the earth's heat emission. For an earth 1,314 million years old the eutectic level lies at 300 kilometers, the radioactive layer is 12 kilometers thick and just $\frac{2}{3}$ of the surface gradient is due to radioactivity. In this ancient earth the highest temperature excess due to radioactivity would be found at and below the bottom of the active layer and would amount to only 106°. This is not much in comparison with the temperature of lavas and, if this age is the highest worth considering, most of the earth's heat must be due to compression.

So great an age as 1,314 million years seems incompatible with other features of the problem. This age implies that a thick shell extending from the compensation level downward to and beyond the eutectic level, a shell more than 200 kilometers in thickness, has cooled after solidification through an average temperature interval of about 600°. Now the geodesists have shown that at the compensation level the strains must be small, and I have given reason for believing these strains even smaller than those computed by the geodesists. But I hold it impossible that a layer of rock 200 kilometers thick can cool 600° without setting up large strains.

On the other hand, no such difficulty arises in the case of an earth 68 million years old, for it is easy to show that only a very small amount of cooling has occurred below its eutectic level. Furthermore, in this case the level of compensation acquires a definite and intelligible physical interpretation. Local fusion would bring about compensation. Where, then, should we look for compensation if not at the eutectic level?

In such speculations as this some latitude must be allowed. If, as the geodesists suspect it may be, the compensation level is as deep as 140 kilometers, and if this is also the eutectic level, the earth is 100 million years old, the radioactive layer is 4.74 kilometers thick and 26 per cent. of the heat emitted by the earth is of radioactive origin.

It has often been asserted that the discovery of radioactivity indefinitely prolongs the probable age of the earth. To me it seems that the determination of the level of compensation limits both the age of the earth and the amount of radioactive matter in its outer shell.

George F. Becker
U. S. Geological Survey

The Constitution of the Atom[1]

The subject of the constitution of the atom has come into extreme prominence—great ad-

[1] From the address of the president of the Royal Society, Sir William Crookes, at the anniversary meeting on November 30, and printed in *Nature*.

vances have been made—while much light has been thrown on the ultimate structure of matter. Years ago, during the persistent and systematic fractionation of yttrium, I explained that I had succeeded in separating the atoms of the so-called elements into groups; these groups undoubtedly exhibited different phosphorescent spectra and presumably had different atomic weights—although from the chemical point of view all the groups behaved similarly. I concluded that, of the lines and bands of the compound spectrum of an element, some are furnished by certain atoms and some by others. I pointed out that this was not likely to be an isolated case; that probably in all so-called elements the whole spectrum does not come from all the atoms—that different spectral rays come from different atoms, which may be interpreted to mean that there are definite differences in the internal motions of the several groups of which the atoms of a chemical element consist. I ventured to suggest a possible explanation of these facts, based on the assumption that acting on the original *protyle* were two forces—one of the character of time, accompanied by a lowering of temperature, while the other, swinging to and fro like a pendulum, and having periodic cycles of ebb and flow, rest and activity, would be intimately connected with the force of electricity. I arrived at a presentation of the elements on a lemniscate path which seemed to me to throw some light on the question of their genesis. My researches seemed to show that the persistence of the ultimate character, the eternal self-existence, the fortuitous origin of the chemical elements, could no longer be regarded merely as probable.

Apparently bodies exist which possess close upon the same atomic weights and combine in definite proportions with other substances and yet exhibit certain minute differences. For these substances, which are capable of being isolated and identified, I suggested the name "meta-elements." Thus there appears to me to be a gradation of molecules of different ranks between the atom and the compound—and these aggregations of atoms in certain circumstances might well pass for simple elementary bodies.

In recent years the old idea of the ultimate atom as a solid particle, spherical or otherwise, has slowly, almost imperceptibly, given way to the more rational conception of a minute planetary or "Saturnian" system of dazzling complexity; the conception is many-minded, aided here and there by facts that failed to fall in with the old lines of thought. Among the most prominent men through which the new conception has come to light, we have Kelvin, Stoney, Thomson, and, more recently, headed by Sir Ernest Rutherford, a host of vigorous workers in the new science of radioactivity, who have built up a conception of atomic physics often "hard to be understood," but that probably is a move in the right direction. Sir Ernest Rutherford supposes the atom to be composed of a nuclear positive charge, exceedingly small compared with the sphere of action of the atom, and consisting of a number of unit charges. Surrounding this nucleus is an external shell in which a number of separate negative electrons are distributed. Professor Soddy—whose name is closely associated with that of Sir Ernest Rutherford—is one of the earliest workers in radioactivity, and has developed a theory of the chemistry of the radio-elements based upon the periodic law and a modified form of lemniscate spiral where the existence of *pseudo*-elements having slightly different atomic weight but identical chemical properties are set out. These "isotopic" elements occupy the same place in the periodic table. He has thus arrived, by a totally different path from the one I traveled, at the conception of an element having atoms of different weight though chemically identical. The theory has recently received some confirmation by the analyses of the lead that is found in the minerals pitchblende, thorianite, etc. In my own laboratory a spectroscopic examination of the lead from Cornwall pitchblende has shown traces of thallium not found in pure assay lead; the unexpected presence of this element may have some bearing on the slightly different atomic weight values recorded for the lead extracted from the radio-minerals.

Without risking a charge of being unduly optimistic I think I may believe we are on the

brink of striking developments in our knowledge of the structure of the elusive atom. Whatever may be the outcome of researches now prosecuted with so much zeal and success, I feel that Addison was speaking with the voice of prophetic truth when, more than a hundred years ago, he said:

> Every atom is a standing miracle and endowed with such qualities as could not be impressed upon it by a Power and a Wisdom less than infinite.

SCIENTIFIC NOTES AND NEWS

The colleagues of Professor Theobald Smith on account of the impending severance of his connection with Harvard University after a service of twenty years to become a member of the Rockefeller Institute of Medical Research, are arranging to present a bas-relief of Professor Smith to the medical school and reductions of this will be made and presented to each donor of $10 or more to the fund. A complimentary dinner will be given to Professor Smith on April 17.

A "Gorgas Medal" to be given yearly in honor of Surgeon-General Gorgas has been established by the medical reserve corps, U. S. army, New York state division. This medal is open to competition to members of the medical corps of the United States army, to medical reserve corps of the army and to members of the medical corps of the organized militia. Officers may submit papers on any subject of a medico-military nature.

The Cornell Society of Civil Engineers held on January 22 in New York City its tenth annual dinner and reunion. The chief guest was Professor Charles D. Marx, of Leland Stanford Junior University, who has recently been elected president of the American Society of Civil Engineers.

Dr. J. Scott Keltie, secretary of the Royal Geographical Society, has been awarded the Cullum gold medal of the American Geographical Society.

The Academy of Natural Sciences of Philadelphia has elected as correspondents Frank Dawson Adams, of Montreal, and Alfred Werner, of Zurich.

Dr. H. E. Robertson, of the University of Minnesota, is working in Professor Aschoff's laboratory and clinic at Freiburg, Baden. He reports himself as the only foreign student at present in attendance. The staff of over thirty members has been reduced to five and the number of students from 130 to 40.

Three physicians of forty who took the recent civil service examination for the position of director of public health education, in the city of New York, have been placed on the eligible list, and President Henry Moskowitz of the municipal commission is reported to have said that an appointment will be made within a few days by Health Commissioner Goldwater. The eligible candidates are: Dr. Ira S. Wile, Dr. Winthrop Talbot and Dr. Charles F. Bolduan.

The Fenger Fellowship of $600 for 1915 has been assigned to Dr. George L. Mathers, of the resident staff of the Cook County Hospital, Chicago, who will carry on work on certain bacteriological problems in pneumonia.

Mr. George P. Vanier, of Steelton, Pa., has been awarded a certificate of merit by The Franklin Institute, Philadelphia, Pa., for his potash bulb. This bulb has been particularly designed for use in the determination, in industrial laboratories, of the total carbon in iron or steel. Mr. Vanier is chief chemist of the Pennsylvania Steel Co., Steelton, Pa. He has also designed zinc tubes and sulphuric acid bulbs for use in connection with the Vanier combustion train for the determination of carbon in steel by the direct combustion method with the electric furnace.

Professor Arthur Keith, conservator of the museum at the Royal College of Surgeons of England, will deliver, during the latter part of March, a course of five lectures on the bearing of recent discoveries on our conception of the evolution and antiquity of man.

Colonel George W. Goethals, who has been appointed Stafford Little lecturer on public affairs at Princeton University for this year, delivered an illustrated lecture on the Panama Canal at Princeton on Wednesday evening, January 27, in Alexander Hall. Owing to the

difficulty in arranging satisfactory dates, there will be only one Stafford Little lecture this year, instead of the usual two. The lecture will be published by the Princeton University Press in the Stafford Little lecture series, the former volumes in the series being by Grover Cleveland, Joseph H. Choate, Elihu Root and J. G. Schurman.

AT the Founder's Day celebration of Clark University on February 1 the speaker will be Dr. R. S. Lillie, professor of biology in the university. His subject is "The Relation of Universities to Investigation."

ON the return from his recent journey west, Dr. Ales Hrdlička, of the U. S. National Museum, lectured, under the auspices of the Archeological Institute, on "The Origin and Antiquity of the American Indian," and on "Evolution of Man in the Light of Recent Discoveries," at San Diego, Los Angeles, Stanford, Berkeley, San Francisco, Denver, Colorado Springs and Pueblo.

PROFESSOR CLARA A. BLISS, of the department of chemistry of Wells College, is on leave of absence for a second year and is studying at Columbia University. Dr. Minnie A. Graham continues as acting professor during Miss Bliss's absence.

MR. N. C. NELSON, of the American Museum of Natural History, has returned from several months' archeological field work in New Mexico, where his work was a continuation of that of previous years on the ancient villages of the Tanos, south of Santa Fé.

ACCORDING to daily papers Mr. Burt M. McConnell, who was secretary to Stefansson, the explorer, and meteorologist of the Canadian Arctic expedition is seeking to induce either the United States government or private citizens to send two hydro-aeroplanes into the far north to search for the explorer, who has not been heard from in over a year. Mr. McConnell has returned from Ottawa, where he tried to interest the Naval Service Department in the project. He was told that nothing could be done at this time. The belief in Canada is that Stefansson and his two companions, Anderson and Storkerson, are still alive and doing the work planned.

THE city of Philadelphia, acting on the recommendation of The Franklin Institute, Philadelphia, Pa., has awarded the John Scott legacy medal and premium to Dr. Charles Edward Guillaume, of Sèvres, France, for his alloy invar. This alloy contains approximately 63.8 per cent. iron and 36.2 per cent. nickel. It is characterized by possessing an extremely small coefficient of linear expansion, about 0.0000004 per degree Centigrade. Within the limits of atmospheric temperature change, its expansion is very exactly proportional to the temperature. It has a modulus of elasticity of about two thirds that of steel, and its hardness is greater than that of hard brass. Invar has found a wide application in metrology and horology. In the former, it is particularly useful for secondary standards of length, and in the latter it is employed for pendulum rods, compensating devices for torsion pendulums and balance wheels correcting the secondary error of temperature in chronometers. Dr. Guillaume has done a large amount of research work in connection with iron-nickel alloys, in the course of which he also discovered platinite.

PROFESSOR LEWIS LINDSAY DYCHE, professor of systematic zoology and taxidermy and curator of birds and mammals in the University of Kansas, died on January 20, at the age of fifty-eight years.

DR. DUDLEY PETER ALLEN, professor of principles of surgery in the medical department of Western Reserve University, Cleveland, for many years, and later emeritus professor, died on January 6, at the age of sixty-two years.

MR. THOMAS BRYANT, a distinguished British surgeon, has died at the age of eighty-six years. He retired from the surgical staff of Guy's Hospital in 1888, delivered the Hunterian oration in 1893 and served as president of the Royal College of Surgeons of England from 1896 to 1899.

SURGEON-GENERAL WILLIAM HENRY MCNAMARA, of the British army, died on January 9, at the age of seventy years.

THE death is announced, at seventy-one years of age, of Lieut.-Col. D. D. Cunningham,

F.R.S., formerly professor of physiology in the Medical College, Calcutta.

At the meeting of the Entomological Society of France on November 11, the president announced the death at the front of Léon Garreta and Jean Chatanay, two lieutenants of the reserve and members of the society. The president also announced that it has been decided to place a tablet in the library upon which shall be engraved the names of members of the society who have fallen and may fall during the war. He also announced that Captain A. Magdelaine and Messrs. J. de Muizon and J. Surcouf, also members, had been wounded but were convalescent, while J. Hervé-Bazin was in the hospital with typhoid fever. All of these men are known to American entomologists through their writings.

The following resolution was unanimously adopted at the annual meeting of the Federation of American Societies for Experimental Biology held in St. Louis, on December 28:

Whereas, Various of the European nations with which many of our members are related by birth, descent or intellectual friendship are now at war,

Resolved, That we extend to the scientific men within these nations the hope of an early and enduring peace, which will leave the nations with no permanent cause of rancor towards each other, and which will insure to each the glories of scientific and humanitarian achievement in accordance with its own conception of these ideals.

The Society of American Bacteriologists held its annual meeting in Philadelphia at the Laboratory of Hygiene, University of Pennsylvania, December 29, 30 and 31, 1914. The following officers were elected:

President: D. H. Bergey.

Vice-president: John Weinzirl.

Secretary-Treasurer: A. Parker Hitchens.

Council: K. F. Kellerman, W. A. Stocking, Jr., R. E. Buchanan and H. J. Conn.

Delegate to the American Association for the Advancement of Science: M. J. Rosenau.

The next regular meeting of the society will be held in Urbana, Illinois. The chairman of the local committee is Professor H. A. Harding. A special meeting of the society will be held in San Francisco during the summer.

The American Microscopical Society at present holds only business meetings. At the recent meeting at Philadelphia the following officers were elected:

President: Professor C. A. Kofoid, University of California, Berkeley, California.

First Vice-president: Professor L. D. Swingle, University of Utah, Salt Lake City, Utah.

Second Vice-president: Dr. N. A. Cobb, U. S. Department of Agriculture, Washington, D. C.

Executive Committee: Professor J. P. Campbell, University of Georgia; Professor L. E. Griffin, University of Pittsburgh; Professor A. L. Weiman, University of Cincinnati.

Representative on the council of the American Association: Drs. H. L. Shantz and R. H. Wolcott.

The report of the custodian showed that the Spencer-Tolles research fund closely approaches $5,000. The income of this fund is now available for aid in research in any microscopic field. Applications should be made to Dr. H. B. Ward, University of Illinois, Urbana, Ill. The membership of the society was shown to have increased steadily for the last four years and now totals 399. The income for the year was $1,380. The secretary of the society is Professor T. W. Galloway, Millikin University, Decatur, Ill.

The American Folk-Lore Society met in Philadelphia, on December 30, 1914, in affiliation with the American Anthropological Association and Section H of the American Association for the Advancement of Science. Dr. Pliny Earl Goddard, president of the society, was in the chair. The papers read were as follows:

"The Relation of Folk Lore to Anthropology (presidential address)," by Pliny Earl Goddard.

"The Knowledge of Primitive Man," by A. C. Goldenweiser.

"European Tales Among the North American Indians," by Stith Thompson.

"The Magic Boat," by Phillips Barry.

Officers elected for 1915 are as follows:

President: Dr. Pliny Earl Goddard, American Museum of Natural History, New York.

First Vice-president: Professor G. L. Kittredge, Harvard University.

Second Vice-president: Professor J. Walter Fewkes, Smithsonian Institution.

Editors: Professor Franz Boas, Columbia University; Professor Aurelio M. Espinosa, Stanford University.

Secretary: Dr. Charles Peabody, Cambridge, Mass.

Treasurer: Mr. E. W. Remick, Boston, Mass.

NEARLY all the papers and practically all the discussion at the recent Chicago meeting of the American Philosophical Association centered on practical ethical questions forced to the front by present international, political, social and economic conditions. The American Philosophical Association and the Western joined in their meetings, and these two in turn had a joint session with the Political Science Association, the Association of American Law Schools, and the American Historical Association, on the subject of Democracy and Responsibility. The officers elected by the American Philosophical Association for the ensuing year are: *President,* Professor A. C. Armstrong, of Wesleyan University; *Vice-president,* Professor W. E. Hocking, of Harvard; *Secretary-Treasurer,* Professor E. G. Spaulding, of Princeton.

THERE has recently been received a notice from Professor Fehr, of Geneva, secretary of the International Commission on the Teaching of Mathematics, giving the decision of the central committee to abandon the meeting planned for August, 1915, and also to postpone the preparation of such committee reports as relate to the work of European countries.

THE new radium laboratories of Manchester Infirmary, which contain radium of the value of £20,000, raised by public subscription a few months ago, have been formally opened by the mayor of the city. A staff of experts will specialize on efforts to apply the radium for the arrest and elimination of cancer. The equipment of the laboratories is second to none in the kingdom, and in the 16 rooms allotted to this special work there is ample provision for administering the treatment to patients.

THE board of managers of the New York Zoological Society held their annual meeting on January 19. It was reported that the Aquarium drew 2,029,707 visitors last year and the park zoological gardens 2,020,433, a substantial increase over 1913. The annual maintenance cost to the city last year was 5.8 cents a visitor, the appropriations being the same as planned for next year, $247,000. On January 1 there were at the park 4,353 animals, representing 1,179 species, and the aquarium 5,169 specimens of 199 species. Animals acquired during the year cost $25,000. The most notable was a female gorilla brought from Africa by an expedition directed by Mr. R. L. Garner.

THE department of public health of the American Museum of Natural History is at present engaged in the preparation of a special exhibit of military hygiene and sanitation, dealing with the health of armies, the hygiene of the individual soldier and the general problems of camp sanitation. A number of new exhibits illustrative of insect-borne diseases were added to the department's display during 1914, the most important single exhibit being a model of the flea (carrier of bubonic plague) 1,728,000 times natural size, prepared by Mr. Ignaz Matausch. The history of the bubonic plague in the past is shown by reproductions of a number of early paintings and by a series of maps illustrating the geographic spread of disease during its historic epidemics. A series of photographs of four American army surgeons who discovered the mosquito transmission of yellow fever, has been hung near the entrance of the hall.

UNIVERSITY AND EDUCATIONAL NEWS

THE alumni of Stevens Institute of Technology were told at their annual dinner in the Hotel Astor on January 23 that their ten-day campaign to raise $1,360,000 had yielded $1,164,269, and that an extension of time had been granted in which the remainder might be collected. Dr. Alexander C. Humphreys, president of the institute, made the confident prediction that the whole amount would be raised by the end of this week.

The Harvard University corporation has set aside $100,000 to pay Belgian professors who have been driven from their land by the war and may give courses at Harvard University next year.

James R. Magee, '59, has left $20,000 and a certain further residuary portion of his estate to Haverford College, to be added to the general endowment fund.

The Evans Museum and Dental Institute Building, which will be occupied by the School of Dentistry of the University of Pennsylvania, will be formally dedicated on February 22.

The Harvard Medical School will hereafter admit as regular students men who have completed two years' work in a college or scientific school of high rank, provided they present certificates (*a*) that they have stood in the upper third of their class, (*b*) that one year's course has been taken in physics, biology, general chemistry and organic chemistry, and (*c*) that they have a reading knowledge of German or French.

DISCUSSION AND CORRESPONDENCE

PROFESSOR DALY'S IGNEOUS ROCKS AND THEIR ORIGIN

To the Editor of Science: Permit me to say a few words in regard to the criticism[1] by Mr. J. P. Iddings of a book recently published by Mr. R. A. Daly and entitled "Igneous Rocks and Their Origin." The criticism is of the destructive, not to say the volcanic, type, and one may well imagine Mr. Iddings laying down his pen with the deeply felt conviction that a heretical and dangerous book has finally been disposed of.

I am afraid Mr. Iddings underestimates the strength of his opponent and he probably does not realize what strong influence the Daly theories, particularly the stoping theory, have on the younger generation of geologists. Mr. Iddings thinks that the author of this book suffers from an exuberant, if not a disordered, imagination. What Mr. Daly thinks about the imaginative qualities of his critic has not, so far, been made public. An impartial observer would probably say that the ideal petrologist would be produced could a "syntectic" assimilation be effected of the two.

It seems to me that Daly's book is one of the best ever written on the subject of igneous phenomena. The principal facts are assembled in the first part of the book, illustrated in abundance from the best sources and from occurrences all over the world. In the second part the theories and hypotheses are set forth, and illustrated in the same lavish manner from the whole world's literature. It is not necessary to agree with all of the author's views; I certainly disagree most heartily with some of them. The book is not a "college petrography" to be put into the hands of the beginner, but the advanced student can not fail to be stimulated by these suggestive and brilliant discussions. Just to point out one line of argument: The theory of gas action, cupolas and "blow-piping" is a most interesting and important subject, very largely neglected in most discourses on intrusions.

As far as his criticism of the "quantitative classification" is concerned, Mr. Daly does not stand quite alone. There are many of us who fail to see in this elaborate system anything but an admirable card classification of analyses.

I venture to suggest, in conclusion, that the unfavorable criticism in Science does not represent the impartial opinion of petrologists in general.

Waldemar Lindgren

Boston, Mass.

[1] Science, November 13, 1914.

SCIENTIFIC BOOKS

Photo-chemistry. By S. E. Sheppard, School of Agriculture, University of Cambridge. Longmans, Green and Company. 1914. Pp. ix + 461.

In this new volume of the series of "Textbooks of Physical Chemistry," edited by Sir William Ramsay, Dr. Sheppard, of Cambridge, presents us with a most painstaking piece of work, and one which for its size is unusually comprehensive. The author presents his sub-

ject-matter in eleven chapters, of which the titles are as follows: Historical—The Measurement of Light Quantities—The Energetics of Radiation—Economic and Energetic Relations of Actual Light Sources—The Absorption of Light—Statics and Kinetics of Photo-chemical Change—Dynamics of Photo-chemical Change—Special Photo-chemistry—Radiant Matter and Photo-chemical Change—The Genesis of Light in Chemical Change—Organic Photo-synthesis.

The first four chapters do not carry us much beyond photo-physics, but give a very satisfactory résumé of those divisions of optical physics which are of primary importance in photo-chemistry. Beginning with Chapter V., the subject-matter becomes increasingly chemical in character, and the book ends with an excellent account of the more recent investigations into the character of the chlorophyll reactions.

To the reviewer the author's method of treatment seems most commendable. Such principles as may be considered thoroughly established are treated with scientific conciseness and brevity, not in general, however, without the presentation of sufficient numerical data for illustration. In dealing with matters which are still in the formative stage, a condition true of so much of photo-chemistry, the author does not dogmatize, but usually leaves the reader with quite the impression that the state of knowledge concerning the subject warrants. This makes the book valuable not only for the knowledge which it imparts, but also for its stimulus to critical thinking.

The book is made up quite directly from the original literature of the subject and is amply provided with citations and references. The author's personality shows itself not only in the thoroughness with which the material has been digested and assimilated, and later organized for the purpose of clear presentation, but also in not infrequent elucidating discussions and in occasional flashes of imaginative explanation. The reviewer's impression is that we have here the work of one thoroughly imbued with his subject, and at the same time entirely competent to handle it. The book should prove valuable not only to those desiring admittance to the charming mysteries of photo-chemistry, but should also be welcome as an additional weapon in the armory of the initiated.

S. W. YOUNG
STANFORD UNIVERSITY

The Hydrogenation of Oils; Catalyzers and Catalysis and the Generation of Hydrogen. By CARLTON ELLIS. New York, D. Van Nostrand Co., 1914. Price $4.00 net.

The book considers very fully the methods of hydrogenation, the various catalyzers, both the base and rare metals, and the mechanism of hydrogen addition. Besides this, the subjects of the analytical constants of the oils and their uses both for culinary purposes and soap making are thoroughly dealt with. About one third of the book is devoted to the methods for the generation of hydrogen, which is of prime importance: these include water gas, decomposition of hydrocarbons, steam on heated metals, acids on metals, the electrolysis of water, and the safety devices for handling the gas.

A feature of the book is the very complete citation of references and patents from the three principal languages.

The volume satisfactorily fills a decided want and may be unreservedly recommended to all interested.

A. H. GILL

A Text-book of Medical Entomology. By WALTER SCOTT PATTON, M.B. (Edin.), I.M.S., King Institute of Preventive Medicine, Madras, and FRANCIS WILLIAM CRAGG, M.D. (Edin.), I.M.S., Central Research Institute, Kasauli, Punjab. Christian Literature Society for India, London, Madras and Calcutta. 1913. Pp. xxxiv + 768. 84 pls. £1–1–0.

The protozoologist, parasitologist or physician who has occasion to deal with the arthropodan carriers of diseases produced by bacteria, Protozoa, or nematodes, has long been hampered in his investigation by reason of

the relative inaccessibility of the pertinent entomological literature. It is widely scattered in expensive journals of restricted circulation, often out of print, and very generally not to be had under any circumstances by workers on the firing line of research in the tropics far from libraries. To investigate even the commonest insects such as the house fly, the flea, the louse and the bed bug, requires an extensive and expensive library and when this is in hand the entomological novice is all too often nonplussed by the exasperating hiatuses in the information available and still more by the perplexing confusion in technical anatomical nomenclature as for example in the case of the wing veins of insects, and the parts of the thorax of the house fly. Text-books of entomology contain so little of the data essential to the workers in the fields of preventive and comparative medicine that they are practically useless as aids to the inquiring specialist.

This need (which has grown so rapidly in recent years) of an adequate text-book in this field bids fair to be very adequately met by Drs. Patton and Cragg's "Medical Entomology." The book is itself a product of this need of this frontier of science, for it has been produced by two experienced workers in the Indian Medical Service, and has been adequately illustrated and well printed in India.

The reader might perhaps infer from this that the book was a provincial one adapted to the locality of its origin. The insects with which it deals are most of them cosmopolitan, often to genera, and in many important instances, as in the fly, flea, louse and some mosquitoes, even to species. But far more important than the objective cosmopolitanism of the work is the broad and comprehensive outlook of the authors and their very sincere and painstaking effort manifest throughout the work, to make the book widely useful, soundly accurate, fairly complete, and wisely proportioned. The result is a treatise which will be indispensable to every worker in medical entomology in tropical or temperate lands.

It treats *in extenso* of insect morphology, drawing its material from those genera and species of medical importance with especial emphasis upon the Diptera. The classification is likewise carefully worked out with detailed treatment where significant, as for example in the case of those most concerned or under suspicion as carriers, such as the Psychodidæ, *Tabanus, Anopheles, Stegomyia,* Œstrid larvæ, *Musca* and *Glossina.* The life-history, breeding habits, seasonal prevalence, relation to environmental factors and the methods of collecting, rearing and feeding are carefully noted and the pitfalls which await the inexperienced worker are very frequently pointed out. One chapter is devoted to the fleas, one to the Rhynchota or bugs, and another which will be especially welcomed, to the Anoplura or lice. In every case the treatment is not restricted to known carriers, but others which are equally wont to fall into the hands of inquiring specialists are included. The known relations to disease are cited as in the many species of *Anopheles,* and the types of parasites known to occur in the insect, their location in the body, and in the life history, and the modes of infection, in fact the full medical bionomics of host and parasite are all briefly summarized.

The Acari and Pentastomida receive a full discussion, especially the first-named group, and there is a brief and rather inadequate section (the last) devoted to *Cyclops* in relation to the guineaworm. A closing chapter deals with those special forms of technique in the preparation of Arthropodan tissues and organs for microscopical examination which are supplementary to the usual lines of instruction given in medical education.

Brief bibliographies of the most important papers, synoptic keys of large groups such as *Anopheles,* by locality, for example of the Philippine Islands, simple but clear and adequate and fairly abundant illustrations, a full index, and a well organized and clearly written text all combine to render very useful an excellent scientific treatise. The defects due to inadequate editing in matters of correlation of references and in elimination of some obscurities of statement, to incomplete or inconveniently located explanations of figures,

and to some important omissions in bibliographies may well be corrected in a later edition.

CHARLES ATWOOD KOFOID
UNIVERSITY OF CALIFORNIA

SPECIAL ARTICLES

THE SIMPLEST CONSTITUENTS REQUIRED FOR GROWTH AND THE COMPLETION OF THE LIFE CYCLE IN AN INSECT (DROSOPHILA)

THE green plants are able to build up all the complicated proteins, polysaccharides and fats of their tissues from nitrates, phosphates and sulphates, on the one hand, and from CO_2, on the other. Those microorganisms which can not form sugar or starch from CO_2 must be offered a more complicated compound than CO_2 for the synthesis of their carbohydrates. They may be able, however, to form all their proteins from an ammonium salt or a single amino-acid. This astonishing synthetic power is in sharp contrast to the behavior of mammals which, according to Osborne and Mendel, can not grow unless one or more proteins are offered to them, for the reason that they lack the power of manufacturing the majority of amino-acids required for the building up of the proteins of their body.

Recent experimenters have pointed out that in addition to the chemically well-defined constituents of food, other more or less mysterious constituents, which only the living body can produce, are required for the growth of mammals. Thus Hopkins, and Osborne and Mendel have found that certain unknown constituents of milk or butter have a specific effect upon the growth of rats, and Allen has found that even a Diatom (*Thalassiosira*) grows incomparably better if one to four per cent. natural sea water is added to the culture medium.

It seemed of interest to find out which substances are required for the growth and the completion of the life cycle of such highly specialized animals as insects. The banana fly (*Drosophila*), on account of the ease with which it can be raised, served as an object for our investigations.

We wish to report only on one group of the experiments we have made, namely, those referring to the source of nitrogenous compounds required for the growth and the complete life cycle of these insects. Our culture medium consisted of a solution of the purest cane sugar or grape sugar obtainable, or of both, to which certain inorganic salts (Kahlbaum's purest) were added. To this medium was added a very small quantity (about 0.25 gram) of mechanically macerated Schleicher and Schüll filter paper (No. 589, "Blue Ribbon"), chiefly to keep the flies from drowning and to facilitate the raising of the larvæ. Dr. Levene was kind enough to have a nitrogen determination of the filter paper made, which showed that its nitrogen content is 0.008 per cent. In such a solution the flies laid their eggs. The larvæ hatched and increased slightly in size during the first days, but then their growth stopped, although they lived for a considerable time. If, however, a small quantity of one or two amino-acids, *e. g.*, alanine or glutaminic acid or others, or certain ammonium salts, *e. g.*, ammonium tartrate or succinate or a combination of one ammonium salt and one amino-acid, was added, the larvæ grew to full size and metamorphosed into pupæ and normal flies.

In these experiments everything used was sterilized, and in addition the culture media were heated for fifty minutes to about 100° C.; but since the flies were not sterile, the development of bacteria was not excluded. The flies were removed as soon as a sufficient number of eggs had been laid. In the majority of experiments no visible fungus formation occurred. When visible fungus growth took place the larvæ, as a rule, soon died or failed to develop.

If in these experiments the larvæ were actually able to manufacture all the complicated nitrogenous compounds of their body from one or two amino-acids or from one ammonium salt, without the aid of bacteria, it would indicate a power of synthesis equal to that of bacteria. In this connection it is of importance that the larvæ of the banana fly can be raised on their natural vegetable food without bacteria. Thus Guyénot has succeeded in raising aseptically forty successive generations of *Drosophila,* thereby proving that for

the normal nutrition of *Drosophila* no bacterial action is required.

It will be our next task to attempt to raise the flies aseptically on our artificial culture media, to decide whether or not in our experiments bacteria performed the work of synthesis for the larvæ.

It was natural to raise the question to what extent the nitrogen content of the filter paper contributed to the result. The fact that no larva was able to grow on filter paper, water, sugar and salts alone indicates that the nitrogen content of the filter paper played practically no rôle in the nutrition. Moreover, the amount of N contained in the filter paper was negligible compared with the amount of N added in the form of amino-acid or ammonium salts. One culture contained, as a rule, 200 mg. glycocoll or other amino acid, *i. e.*, roughly between 30 and 40 mg. of nitrogen. The 250 mg. of filter paper added to the culture contained only 0.02 mg. of nitrogen. The nitrogen in the filter paper was therefore about between 1/2,000 and 1/1,500 of the total nitrogen in the culture medium. Nevertheless, it is a fact that in liquid cultures without filter paper—in this case glass beads were used to prevent the drowning of the flies—the yield of larvæ was very much smaller than with filter paper. It should also be stated that the larvæ ate little if any of the filter paper. It will be one of the tasks of our further experiments to find out what caused the difference in the two cases.

Jacques Loeb

The Rockefeller Institute
for Medical Research,
New York

THE BOTANICAL SOCIETY OF AMERICA

The ninth annual meeting of the Botanical Society of America was held in the Medical School of the University of Pennsylvania, Philadelphia, Pa., December 29–31, 1914. The following officers were elected for the ensuing year:

President—John M. Coulter.
Vice-president—R. A. Harper.
Treasurer—Arthur Hollick.
Councilor—W. F. Ganong.

The resignation of George T. Moore as secretary was accepted and Mr. H. H. Bartlett, of the Department of Agriculture, elected to fill the unexpired term.

The council for 1915 will consist of above officers and George P. Atkinson and David Fairchild.

The following botanists were elected to membership: Adeline Ames, Department of Agriculture, Washington, D. C.; E. G. Arzberger, Bureau of Plant Industry, Washington, D. C.; Freda M. Bachmann, Milwaukee Downer College, Milwaukee, Wis.; Samuel M. Bain, University of Tennessee, Knoxville, Tenn.; A. L. Bakke, Ames, Iowa; Henry W. Barre, Clemson College, S. C.; H. P. Barss, Oregon Agric. Coll., Corvallis, Oregon; R. Kent Beattie, Bureau of Plant Industry, Washington, D. C.; Albert T. Bell, University of Louisiana, Baton Rouge, La.; H. M. Benedict, University of Cincinnati, Cincinnati, O.; R. C. Benedict, 2303 New Kirk Ave., Brooklyn, New York; Charles Brooks, Bureau of Plant Industry, Washington, D. C.; E. P. Bicknell, 30 Pine St., New York City; Guy R. Bisbey, Brooklyn Botanic Garden, Brooklyn, N. Y.; Harry P. Brown, 219 Linden Ave., Ithaca, N. Y.; Stewardson Brown, 20 East Penn St., Philadelphia, Penna.; Edward Sandford Burgess, Hunter College, New York City; Gertrude S. Burlingham, 556 Lafayette Ave., Brooklyn, N. Y.; George H. Chapman, Mass. Agric. College, Amherst, Mass.; C. Harvey Crabill, Va. Agr. Exp. Sta., Blacksburg, Va.; Richard O. Cromwell, North Carolina Agric. Exp. Sta., West Raleigh, N. C.; Gilbert Cameron Cunningham, Burlington, Vt.; Charles C. Deam, Bluffton, Indiana; W. W. Eggleston, Dept. of Agriculture, Washington, D. C.; John H. Ehlers, Univ. of Michigan, Ann Arbor, Mich.; Julia T. Emerson, 131 East 66th St., New York City; T. J. Fitzpatrick, Cotner University, Bethany, Nebraska; Eloise Gerry (U. S. Forest Service), 616 Lake St., Madison, Wis.; Melvin R. Gilmore, Neb. His. Soc. Museum, Lincoln, Nebraska; John P. Helyar, New Brunswick, New Jersey; Bascombe Britt Higgins, Georgia Exp. Sta., Experiment, Georgia; H. B. Humphrey, Dept. of Agric., Washington, D. C.; L. M. Hutchins, Bureau Plant Industry, Washington, D. C.; H. S. Jackson, Oregon Agric. College, Corvallis, Oregon; Cyrus A. King, Erasmus Hall High School, Brooklyn, N. Y.; B. F. Lutman, University of Vt., Burlington, Vt.; Fred McAllister, University of Texas, Austin, Texas; Walter B. McDougall, University of Illinois, Urbana, Ills.; S. M. McMurran, Bureau of Plant Industry, Washington, D. C.; K. K. Mackenzie, 139 North Walnut St., East Orange, New Jersey; W. E. Manewal, Univ. of Virginia, Charlottesville, Va.; H. F. Meier, Syracuse University, Syracuse, N.

Y.; H. G. MacMillan, Univ. of Wisconsin, Madison, Wis.; J. N. Martin, 507 Welch Av., Ames, Iowa; Edgar Nelson, Gainesville, Fla.; J. B. S. Norton, Maryland Agric. Exp. Station, College Park, Md.; P. J. O'Gara, Medford, Oregon; A. Vincent Osmun, Mass. Agric. College, Amherst, Mass.; Frederick S. Page, University of Vermont, Burlington, Vt.; A. K. Peitersen, University of Vermont, Burlington, Vt.; Fermen L. Pickett, Bloomington, Indiana; J. M. Reade, University of Georgia, Athens, Georgia; J. W. Roberts, Dept. of Agric., Washington, D. C.; Winifred J. Robinson, Vassar College, Poughkeepsie, N. Y.; John Henry Schaffner, Ohio State University, Columbus, Ohio; Annie Morrill Smith (Mrs.), 78 Orange St., Brooklyn, New York; Neil Everett Stevens, Bureau of Plant Industry, Washington, D. C.; Wilmer G. Stover, Ohio State University, Columbus, O.; G. P. Van Eseltine, U. S. National Herbarium, Washington, D. C.; Arno Viehoever, Department of Agriculture, Washington, D. C.; J. R. Weir, Bureau of Plant Industry, Washington, D. C.; John Minton Westgate, Department of Agriculture, Washington, D. C.; R. B. Whitney, Institute of Industrial Research, Washington, D. C.; Yungyen Young, University of Illinois, Urbana, Ill.; John A. Stevenson, Estacion Insular, Rio Piedras, Porto Rico.

The following members were elected Fellows: Frank M. Andrews, LeRoy Abrams, Carleton R. Ball, Joseph S. Caldwell, G. N. Collins, Arthur J. Eames, Theodore C. Frye, Leonard L. Harter, Charles F. Hottes, Lewis Knudson, Wanda M. Pfeiffer, S. B. Parish, Frederick J. Pritchard, J. B. Rorer, Charles A. Shull, Edmund W. Sinnott, Laetitia M. Snow, William C. Stevens, U. E. Safford, Walter P. Thompson, Reinhardt Thiessen, James M. Van Hook.

On the afternoon of December 30 a symposium on "The Genetic Relationship of Organisms" was held. The subject was considered under the following heads:

1. "Morphology as a Factor in Determining Genetic Relationships." Dr. J. M. Greenman, Missouri Botanical Garden.

Discussion led by Dr. A. S. Hitchcock, Department of Agriculture.

2. "The Genetic Relationship of Parasites." Dr. F. D. Kern, Pennsylvania State College.

Discussion led by Dr. C. L. Shear, U. S. Department of Agriculture.

3. "The Experimental Study of Genetic Relationship." Dr. H. H. Bartlett, U. S. Department of Agriculture.

Discussion led by Dr. B. M. Davis, University of Pennsylvania.

The address of retiring President D. H. Campbell, on "Present Tendencies in Botanical Work in America," was delivered at the dinner for all botanists on the evening of December 30.

An Endophytic Endodermal Fungus in Solanum tuberosum: E. MEAD WILCOX, GEO. K. K. LINK AND FLORENCE A. MCCORMICK.

A preliminary account of an endophytic fungus in *Solanum tuberosum*. This fungus is found throughout the whole plant but is confined to the endodermis, and, in the usual vegetative propagation of the potato proceeds from the tuber through the shoots to the daughter tubers. A discussion of its possible relation to tuberization is included.

Report on Cultures with Foliaceous Species of Peridermium on Pine Made in 1914: GEORGE G. HEDGCOCK AND WM. H. LONG.

This paper gives a summary of an extensive series of experiments with six of the foliicolous species of *Peridermium* on pines of the United States, viz., *Peridermium acicolum* Underw. & Earle, *P. carneum* (Bosc.) Seym. & Earle, *P. delicatulum* Arth. & Kern, *P. inconspicuum* Long, *P. intermedium* Arth. & Kern, and *P. montanum* Arth. & Kern. A total of 712 inoculations were made with these species and the species of *Coleosporium*, of which these *Peridermia* are alternate forms. The results of the experiments are revolutionary, since they indicate that at least four of these species of *Peridermium* and the related species of *Coleosporium* belong to one polymorphic species, and that the transfer from one herbaceous host to another is accomplished through the aecial forms in the pines.

Origin and Development of the Lamellae in Coprinus comatus, atramentarius and micaceus: GEORGE F. ATKINSON.

The origin and development of the lamellae is described and compared with the two types already known in Agaricus and Amanitopsis.

The Specific Identity of Phallus impudicus and Dictyophora duplicata: GEO. F. ATKINSON.

The only differential character between these two species is the possession of an indusium by the latter. The indusium varies in strength of development. Sometimes it is strongly developed, sometimes very weakly so, sometimes wanting or only a fundament of it in the embryonic stage.

The Relationship of Endothia parasitica and Related Species to the Tannin Content of the Host Plants: MEL. T. COOK AND GUY WEST WILSON.

Endothia parasitica (American and Chinese strains), *E. radicalis* and *E. radicalis mississippiensis* were grown on a culture medium to which had been added different percentages of commercial tannin and special extracts prepared by Mr. George A. Kerr. Extract "1-X" was soluble in water; "2-X" in water and alcohol; both were tannins, and the second between 95 and 100 per cent. pure. A third extract, "3-X," contained the coloring matter which is usually estimated as tannin. The results of the experiments indicate (1) that commercial tannins are variable and probably not pure tannin; (2) that ordinary commercial tannin and pure tannin extracts are not the same; (3) that we do not know the form or quantity of tannin or tannin-like substances with which the fungus comes in contact in the host plant; (4) that the food supply influences the vigor of the fungus and its power of resistance; (5) that high percentages of tannin usually cause a retardation of germination, frequently followed by an abnormal growth of aerial mycelium; (6) *E. radicalis mississippiensis* was most resistant, *E. parasitica* second and *E. radicalis* third; (7) that the American strain of *E. parasitica* was more resistant than the Chinese strain; (8) *E. parasitica* may feed to some extent on the tannin; (9) specially prepared pure tannin extracts were less toxic than commercial tannin; (10) coloring materials which are usually estimated as tannins were toxic; (11) tannic acid is toxic to many parasitic fungi, but there are other compounds associated with it which are more toxic and which may be more important in the economy of the host plant.

A New North American Endophyllum: J. C. Arthur and F. D. Fromme.

The supposed aeciospores of *Aecidium tuberculatum* Ellis & Kellerm. were found to produce promycelia and basidiospores when germinated on the surface of water or of a non-nutrient agar or gelatine. They are, therefore, to be considered teliospores of the same character as those present in the genera *Endophyllum* and *Gymnoconia*. The morphological features of this species, especially the cupulate, bullate sorus and the presence of a peridium, together with the habit of perennating in the host are characteristic of the genus *Endophyllum*.

The fungus occurs on species of *Callirhoe, Sidalcea* and *Althaea* in Kansas, Nebraska, Colorado and Wyoming.

This is the first North American rust whose assignment to the genus *Endophyllum* has been proved by germination tests.

How to Use Aecium and Similar Terms: J. C. Arthur.

The terms pycnium, aecium, uredinium and telium and their derivatives were introduced into the terminology of mycology by the writer in 1905. These terms were intended to meet certain definite requirements, and not as simplified forms of terms in common use. They have been accepted by many writers, either wholly or in part, and have been accorded a place in recent large dictionaries. The present paper is intended to point out the application of the terms, and to show wherein some extension of the terms has developed which impairs their value and is likely to lead to confusion of ideas.

Cultures of Uredineae in 1912, 1913 and 1914: J. C. Arthur.

The present report continues a series extending over sixteen consecutive years on the results obtained from protected cultures of various species of rusts. Out of the very large number of trials made during the three years covered by the report, about seventy were successful in producing infection, involving about thirty species. Probably half the successful cultures do little more than confirm previous work with the same species. A large part of the remainder, however, extend our knowledge of the species considerably. Some show that what have been considered valid species, *e. g.*, *Puccinia tosta, P. vulpinoidea* and *P. Dulichii*, are to be reduced to synonymy. A few cultures demonstrated the full life history of species never before cultured.

The North American Species of Allodus: C. R. Orton.

The genus *Allodus* of the Uredinales was founded by Arthur in 1906 and embraces those species of the genus *Puccinia* auct. which have only pycnia, aecia (aecidium type) and telia in their life cycle. The present study has been made almost entirely from the taxonomic standpoint and shows in North America about forty-eight species,

Diagnostic descriptions and a key to the species are included, together with discussions and notes of interest to investigators in this class of fungi.

Foreign species have been carefully compared, but are not included in the present paper.

Correlated species of rusts in the genera *Dicaeoma, Dasyspora* and *Uromycopsis* have been enumerated so far as time has permitted, and show some interesting genetic relationships.

North American Rusts with Caeoma-like Sori: C. A. LUDWIG.

This paper takes up a discussion of the caeoma-like stage in the life history of certain North American rusts. A caeoma is understood to be a structure in which the spores are catenulate and the sorus is not delimited by peridium, paraphyses, or similar means for preventing true coalescence of sori. The material thus included is divided into five groups represented by the genera *Coleosporium, Melampsora, Neoravenelia, Gymnoconia* and *Eriosporangium* (in part). An attempt is made to arrange the species of *Coleosporium* chiefly according to their morphological characters with a view to the ultimate combination of some of them, since it seems likely that there are "more species of *Coleosporium* in the books than in nature." In the *Melampsora* group one new combination is made and one new species described. In the genus *Eriosporangium* the species *E. Hyptidis* (M. A. Curt.) Arth. is shown to have a distribution limited to the United States instead of extending to the West Indies and Central America, as heretofore considered.

The Penicillium Group—Verticillatae of Wehmer: CHARLES THOM.

A series of strains of *Penicillium* beginning with the ascugerous form of *P. luteum* and ending with *P. purpurogenum* are linked into a series by certain common characters. The conidiophore produces a single whorl of fertile branches (metulae). Wehmer uses this character to name a section, Verticillatae, of the genus. Each branch bears a verticil of sterigmata or conidia-bearing cells, closely parallel, enlarging from the base upward 5–8 microns, then tapering to form a lanceolate point ending in a conidium-producing tube, with a total length from 12 to 15 microns. The conidia in the series are elliptical, or more or less fusiform, rarely approach to globose, smooth or slightly rough, with a majority of spores in each culture, showing a size typical of the strain, while some vary widely enough to approach the range of size found in the group 2 to 3 by 2.5–4 microns. In colony character, the surface mycelium shows yellow granules which in some become reddish with age and changed reactions. The amount of yellow depends (1) upon the amount of surface growth, hence becomes abundant if the colony is floccose or is very slight in strains with short, separate conidiophores; (2) in the quantity of green conidia produced thus *P. luteum* shows only a trace of green and *P. purpurogenum* only a trace of yellow.

The species at the *P. luteum* end of the series produce orange shades in substrata containing sugars with only partial, or slow, transformation to red. *P. purpurogenum* and its close allies produce only traces of this orange color, but an abundance of a rich red coloring matter. Cultures will be shown to illustrate these points.

Spermatia of the Higher Ascomycetes: B. B. HIGGINS.

While studying the life cycle of some fungous parasites during the last two years, spermatia have been found in some twenty species. In all cases studied they develop late in the fall simultaneous with the development of young stages of the ascocarp and, in at least eleven species, with carpogonial structures.

These twenty species are scattered through four orders of the Ascomycetes, viz., *Phacidiales, Perisporiales, Dothidiales* and *Sphaeriales,* which indicates that spermatia are of quite general occurrence and may have an important bearing on the classification and relationships of the group.

The Papulospora Question as Related to Ascobolus: B. O. DODGE.

Species of fungi producing so-called *Urocystis*-like spores, papulospores, are found in several widely separated groups. Many of such forms have been connected with hypocreaceous Ascomycetes.

I have found a *Papulospora* closely associated with *Ascobolus magnificus* either as a parasite or as an asexual spore form of the *Ascobolus.* If the former is the case the mycelium of the parasite is intrahyphal; if the latter be true, then the phenomenon known as "Durchwachsung" is extremely complicated in the mycelium of this *Ascobolus.*

Further recent comparisons of papulospores with those of *Urocystis* and their description as independent Hyphomycetes are quite beside the question. It is plain that they are spore bodies either of the perfect stage of the fungus with which they are associated or of a parasite upon that fungus.

The Effect of Centrifugal Force on Plants: F. M. ANDREWS.

Climatic Distribution of the Various Types of Angiosperm Leaf-Margin and Their Physiological Significance: I. W. BAILEY AND E. W. SINNOTT.

Root Habits of Desert Plants and the Reaction of Roots to Soil Temperature: W. A. CANNON.

There are three well-marked types of roots of

the desert perennials. These are in brief: (1) roots which never penetrate the ground deeply, whatever may be its character. Most cacti have roots of this kind; (2) roots which penetrate deeply and which have a few or no roots near the surface of the ground. A typical example is found in *Koeberlinia*, although *Prosopis*, also, usually has roots of this type. And, finally, (3) many plants have roots which are intermediate between these extreme forms, and which may be said to be of a generalized character. *Covillea*, and many other species, have generalized root-systems.

The absorbing roots of the superficial type, type 1, lie, for the most part, from 5 to 15 cm. beneath the surface, while the anchoring roots are usually not much over 30 cm. deep. Since most of the roots of this type are absorbing roots, it follows that most of the roots are placed close to the surface of the ground. The deeply placed roots, type 2, on the other hand, may lie from 2 m. to 5 m. and much deeper, and have few superficial absorbing roots. The generalized root-systems may occupy any horizon between immediately beneath the surface of the ground and a depth of 2 m. or over. There is apparently no differentiation into anchoring and absorbing roots in class 2 and class 3.

A study of the mean maxima soil temperatures for a depth of 15 cm. and 30 cm. shows that the annual swing is from 46.5° F., in January, to 94.5° F., in July, at the shallower depth, and from 39.0° F., to 87.5° F., at the greater depth. Thus there is a difference at the beginning of the most active growing season of 7° F., in soil temperatures between a depth of 15 cm. and a depth of 30 cm. The temperature decreases with depth, so that as far as the records show, at depths less than 15 cm. the maxima temperatures in midsummer are greatest.

From the striking difference in root habit and from the marked difference in soil temperatures which comes with variation in depth, it follows that, in nature, plants having root habits of so diverse a character as has been given must needs be exposed to widely different temperature conditions of the soil.

Associated with the fact last presented is the one that perennials, with different root habits, have each their characteristic reaction to soil temperatures. For example, *Prosopis*, with a deeply penetrating root-system, exhibits, so far as its roots are concerned, active growth between temperatures (less than) 15° C. and 42° C. While *Fouquieria*, with a root-system resembling very nearly that of the cacti, exhibits little root growth in soil temperature under 20° C., and the same is true of *Opuntia versicolor*. The rate of growth increases with temperature rise until an optimum is reached between 30° C. and 35° C., although growth continues to 40° C., and above.

Thus, to an extent not now known, perennials with strikingly different root types show unlike and characteristic response to soil temperatures. It is thought that the difference in temperature response, coupled with differences in soil temperature, are the definitive factors which bring about the characteristic distribution in the soil of the roots of the species studied. It is largely because of these conditions, also, that "exposures" are so important in determining the characteristic distribution of many species, especially in arid or semi-arid regions.

Effect of Temperature on Glomerella: C. W. Edgerton.

Different species or strains of the genus *Glomerella* respond differently to different temperatures. One form, the one found on bean, *Colletotrichum lindemuthianum*, is very susceptible to high temperatures, growth ceasing at about a temperature of 31° C., thus explaining why this form is not prevalent during the hot part of the summer or in warm climates. The different *Glomerella* strains fall into several classes in regard to the temperature factor. These classes are represented by such forms as *Collectotrichum lindemuthianum*, *Colletotrichum lagenarium*, a slow-growing form from apple, a fast-growing form from apple, and *Gloeosporium musarum*. Nearly fifty different cultures have been grown at temperatures ranging from 14° C. to 37.5° C.

The Nature of Antagonism: W. J. V. Osterhout.

As the result of his studies on permeability the writer finds it possible to predict what substances will antagonize each other in their action on living tissues. This opens the way to a general theory of antagonism.

The Chemical Dynamics of Living Protoplasm: W. J. V. Osterhout.

By means of electrical measurements it is possible to follow reactions in living protoplasm without interference with the progress of the reaction or injury to the protoplasm. It is thus possible to determine the order of the reaction and to ascertain whether the reaction is reversible. It appears in many cases that the reaction is reversible up to a certain point; beyond this it is irreversible. The reasons for this are discussed.

The Nature of Mechanical Stimulation: W. J. V. OSTERHOUT.

The chief difficulty which a theory of mechanical stimulation must meet is the production of chemical reactions by a mechanical disturbance. This difficulty is met by supposing that the mechanical disturbance breaks down semipermeable surfaces, thus allowing substances to react which were previously kept apart. Experimental evidence is brought forward in support of this view.

Studies in Plant Oxidases: G. B. REED.

1. *Evidence for the General Distribution of the Oxidases.*—Some algae which have been reported to be without oxidases were found to contain a ferment capable of activating the oxidation of a specific group of compounds.

2. *The Formation of Indophenol Granules.*—Indophenol granules were found to form in cells which had been killed by agents which do not affect oxidases, but did not form in cells killed by agents known to destroy oxidases.

3. *On the Separation of Oxidase Reactions from the Caralase Reaction.*—By subjecting colloidal platinum to active oxygen at an anode its oxidase activity towards gum guaiacum and potassium iodide was increased, while its catalase activity was decreased; and by treating with active hydrogen at a cathode the opposite effects were produced. Bright platinum after anodic oxidation has a definite oxidase action, but no catalase action. Some plant extracts were found which contained oxidases, but no catalase.

4. *An Acid-stable Oxidase.*—While the oxidases are ordinarily inhibited by a slight degree of acidity, an oxidase was obtained from pineapples and some other fruits capable of withstanding 0.1 M. HCl.

Enzymes of the Marine Algæ: A. R. DAVIS.

Continuing the work begun with *Fucus,* isolation and identification of enzymes occurring in representative marine forms of the greens, browns and reds has been carried on. The results obtained show certain differences for the different groups of algæ: carbohydrases attacking the various polysaccharides are generally distributed in the greens and reds; when present in the browns they are much less active, and in a few genera have not yet been detected with the methods used. Compared with potato leaf tissue prepared in the same way, the carbohydrase activity of *Ulva lactuca,* the most active form studied, was about half.

Proteinases acting upon albumin, legumin and peptone in neutral and alkaline solution were isolated from the majority of the forms worked with and, as was true for the carbohydrases, were most active in certain of the greens and reds. No amidase action was observable.

With the exception of a few forms lipase was found to be very generally present, being especially active in *Chondrus* and *Desmerestis;* on the other hand, fatty esters were not acted upon.

Oxidases and peroxidases were found in but one form—*Agardhiella.* In this both were quite active, comparing favorably with potato tuber tissue. Catalases were present in all forms.

The total number of enzymes isolated was small when compared with the tissues of the higher plants, and their action decidedly slower. In general this action was greater in the greens and the reds than in the browns.

Concerning the Measurement of Diastase Activity in Plant Extracts: CHAS. O. APPLEMAN.

Several methods have been proposed for the measurement of the velocity of diastase activity in plant extracts. The procedure adopted by several investigators is based upon the determination of the amount of reducing sugar, usually calculated as maltose, produced by the action of a definite amount of extract upon an excess of soluble starch for a definite length of time at constant temperature. The Kjeldahl "law of proportionality" is sometimes observed and sometimes ignored. The general inapplicability of this method for plant extracts is very strikingly shown in the following table, which refers to the diastase activity in glycerine extracts from cold storage potatoes:

TABLE I

Date of Analysis	Increase in Milligrams of Sugar at 40° C. Per Hour Per 100 Grams of Potato Pulp: Total Reducing Sugar Calculated as Maltose	Total Sugar
November 28	17.0	3.6
December 20	24.6	3.7
January 13	81.9	3.7

Calculated on the basis of increase in total reducing sugars or maltose in the extract after incubation with soluble starch, the tubers would show a very marked increase in diastase with storage, but when calculated on basis of increase in total sugar, the diastase activity remains practically constant. The amount of sucrose in the tubers increases with cold storage. It is extracted with the diastase and is inverted at the incubation temperature, according to the law of the mass action.

Since non-reducing, hydrolyzable sugars are present in many plant tissues and are subject to wide variation in the same tissue, the above described method in unmodified form is not reliable.

Electrolytic Determination of Exosmosis from the Roots of Anesthetized Plants: M. C. Merrill.

Subjecting growing plants of *Pisum sativum* to the influence of illuminating gas and ether vapor causes a marked exosmosis from the roots. The plants were grown for several days in full nutrient solution and, after thorough rinsing of the roots, were placed in redistilled water whose specific conductivity was approximately .000002. Immediately afterward the plants were subjected for varying periods to the gas or vapor, and the effect determined by frequent measurements of the conductivity of the water as contrasted with that in which control plants were placed and also by subsequently growing fresh seedlings in the water.

The exposures were made in all cases under bell jars. Where the roots were exposed directly to the anesthetics the resulting exosmosis was more rapid than where the roots were kept in the water during the exposure. In the former case the root turgor decreased greatly, while in the latter case the tops were affected, but the roots remained normal in appearance even though the exosmosis was abundant, thus indicating a disappearance of mineral nutrients from the tops. With older plants the increased conductivity was less than with younger plants, thereby indicating greater resistance to the anesthetics.

Some Relations of Plants to Distilled Water and Certain Dilute Toxic Solutions: M. C. Merrill.

A careful determination was made of the interval during which *Pisum sativum* seedlings could grow in redistilled water and in certain toxic solutions, and then recover when later placed in full nutrient solution. The benefits to be derived from renewing the distilled water every four days, as contrasted with the condition where it was not renewed, were evidenced in most cases by better growth in the distilled water or greater recovery in the full nutrient solution. Horse beans (*Vicia faba*) were more marked than *Pisum sativum* in their behavior toward the renewal of the distilled water, those in which the distilled water was renewed showing more than double the growth. Bacterial and fungous action is undoubtedly an important factor, as demonstrated by the effect of boiling the water. The evidence indicates that there are several factors entering into the so-called harmful action of distilled water. Striking changes in the conductivity of the distilled water were found when plants were placed in it during various stages and conditions of growth.

Revegetation of Abandoned Roadways in Eastern Colorado: H. L. Shantz.

A roadway consisted of a trail formed by driving repeatedly over the short grass sod. After a few years a new road was formed at the side of the old trail. In this way many roads were formed and successively abandoned. The plant succession on these abandoned roadways consists of an early and late ruderal association followed by either the *Artemisia-Gutierrezia* association or the wire-grass association. The final stage or Grama-Buffalo grass association becomes established in from twenty to thirty years.

Is the Flora of the Prairie and Steppe of Arctic Origin?: B. Shimek.

The conclusion of the paper is opposed to the widely prevalent conception that the flora of the steppes (and incidentally of the prairies) is of Arctic origin, and that the "steppe" condition is an evidence of a colder climate. The fact that certain plants (and, even more conspicuously, certain animals), more particularly in Europe, are now found only in the far north, but formerly existed much farther south, is not regarded as evidence of a much colder earlier climate in these more southerly regions, for we probably have to deal here with remnants of a formerly widespread flora and fauna now largely restricted through man's influence.

Comparisons are made of plant lists showing distribution in both Europe and North America, and on this basis, and on the basis of structural adaptation to habitat, and habit, the conclusion is drawn that the plants of these treeless areas reached their present state under the influence of dry conditions, and that their present distribution was accomplished by advance from regions south of the glacial limit.

Growth-forms of the Flora of New York and Vicinity: Norman Taylor.

The study of climate, through the study of the vegetative response to it, involved the dividing of all vegetation into 10 or 12 different categories. Raunkiaer has called these "growth-forms," which are based on the amount and kind of protection exhibited by the growing or perennating shoots during the winter or critical season. The usefulness of the method lies in its value as a basis of comparison between different floras, different elements of the same flora, and even smaller cate-

gories of vegetation. By calculating the percentages of the growth-forms in the flora of different regions, we get the record of the vegetative response to climate, with all its infinite variation. Applying the method for the flora of the vicinity of New York, where, excluding weeds, ferns and parasites, there are 1,907 wild species, the percentages of growth-forms are as follows:

Megaphanerophytes	.52 per cent.
Mesaphanerophytes	4.03 per cent.
Microphanerophytes	7.18 per cent.
Nanophanerophytes	3.51 per cent.
Chamaephytes	5.29 per cent.
Hemicryptophytes	33.29 per cent.
Geophytes	20.23 per cent.
Helophytes and Hydrophytes	11.74 per cent.
Therophytes	13 per cent.

The percentage of geophytes is larger than that for any region yet studied, leading to the conclusion that the climate near New York is of such a nature that the development of geophytes is especially favored. Studies were also made on the northern and southern elements of the flora of New York, and on the high-mountain species of the region; the percentage of growth-forms being given for each of these groups, and for different regions of the earth's surface to compare with the local flora near New York.

The Effect of Breeding and Selection upon the Percentage of Total Alkaloids in some Species and Hybrids of the Genus Datura: FRED A. MILLER AND J. W. MEADER.

Through selection and hybridization an attempt has been made to develop a strain of stramonium which would show an increased percentage of alkaloids over that of the commercial stramonium leaf used for medicinal purposes. All selected plants have been carefully inbred. The alkaloidal assays have been made upon samples of air-dried leaves from individual plants. The species so far used are *Datura stramonium* L., *D. tatula* L. and *D. ferox* L.

On the Nature of Mutations: R. RUGGLES GATES.

Hybrids of Œnothera biennis Linnaeus and O. franciscana Bartlett in the First and Second Generations: BRADLEY MOORE DAVIS.

Among the contrasting characters of the parent species is one especially well adapted to a genetical study. In *Œnothera biennis* the papillae at the base of long hairs follow the color of the green stems; in *O. franciscana* the papillae are bright red. Hybrids of reciprocal crosses all have red papillæ, the color thus appearing as a simple dominant. Cultures of the hybrids in the second generation totaled 1,806 plants from sowings of 3,554 seed-like structures; 1,679 rosettes sent up shoots during the season, and on every one of these plants the papillæ were bright red. There was thus a failure of the color character to segregate in the F_2 in cultures containing 1,679 plants, and its behavior was not what might have been expected from Mendelian experience. However, it should be noted that of the 3,554 seed-like structures sown 1,748 failed to germinate, although seed pans were kept for 8–10 weeks. Also that 127 plants either died during the season or else, remaining as rosettes, failed to send up shoots upon which observations could be made. It is thus possible that the absence of a class of green-stemmed recessives may be associated with this high degree of seed sterility, the cause of which is as yet not known, or with the failure of some plants to mature.

In previous papers mention has been made of the fact that the F_1 hybrids of the cross *franciscana* × *biennis* in many characters were similar to *Œnothera Lamarckiana*, differing from this plant only in relatively small plus or minus expressions of these characters. The second generation of this cross, as was to have been expected, presented a wide range of forms, and among these were a number of plants with combinations of characters that appear to have fulfilled in essentials the requirements of a synthetic *Lamarckiana*-like hybrid. Further generations from these selected plants will be grown to test their further range of variation.

A detailed account of the above-considered cultures will later be published.

Inheritance of Certain Seed Characters in Corn: R. A. HARPER.

The various pigmentations of the integument, aleurone layer and endosperm are metidentical characters in Detto's sense, that is, the same in the cells as they are in the tissues or the kernel, as a whole. The pattern in the case of streaked or mottled grains is a character of the tissue, as a whole. The form of the dent kernels is a character of the kernel, as a whole, due to the nature and distribution of the starch and other elements in the tissues. The wrinkled form of the kernels of sweet corn is more nearly identical with the shrinkage of the individual cells of the endosperm. By crossing, intermediates may be obtained between any two such contrasting charac-

ters, and selection tends to develop fixity of type, though the range of variation may at first be even higher than that of the parent types.

Inheritable Variations in the Yellow Daisy (Rudbeckia hirta): Albert F. Blakeslee.

Variations in the following characters have been found in the wild yellow daisy: absence of rays and their presence in rather definite numbers from 8 to 30 and to perfectly double forms; width of rays; diameter of head from 1 to 5½ inches; color of rays from pale straw color to deep orange; relative intensity of color in inner half of ray forming a lighter or darker ring; different intensities of mahogany color at base of ray on upper side; mahogany on under side of ray; constriction of ray at tip, at middle, or at base—those constricted at tip either rolled in or rolled out to give the "cactus" type seen in *Dahlias*—those constricted at base without change in color or characterized by lighter color or by presence of black pigment on constricted areas; transformation of rays into tubes giving "quilled" type; the position of rays, bending upward, horizontal, reflexed, straight or variously twisted; the shape and size of disk; the color of disk from yellowish green through several grades of purple to almost black; vegetative characters such as height, branching, size and shape of leaf, fasciations, etc.

Evidence from the distribution of the variants in nature and from their reappearance in sowings from open-pollinated heads shows that most, if not all, these variations are inherited. The basal splash of mahogany on the ray seems to be inherited as a simple Mendelian dominant. Other characters are being investigated.

Bud Variations in Coleus: A. B. Stout.

The phenomena of bud variation in *Coleus* and the behavior of pedigreed plants of vegetative propagation illustrate, in the case of red pigmentation, most clearly the behavior of a metidentical character, and show equally well that the distribution of colors in patterns is epigenetic in nature, and is, without doubt, due to physical and chemical processes quite analogous to the Liesegang precipitation phenomena by which Gebhardt reproduced in a most striking manner certain markings that occur in the wings of butterflies.

Plants propagated vegetatively through six generations developed two types of changes: (1) fluctuations and (2) mutations. Although the different patterns which arose were remarkably constant in vegetative propagation, each exhibited further changes in the epigenetic development and distribution of the red pigmentation. The phenomena associated with the appearance and subsequent behavior of the different bud variations are quite similar to the phenomena of variation, mutation and alternative inheritance in a seed progeny of hybrid origin.

The Morphology of the Œnothera Flower: George Harrison Shull.

The hypanthium of *Œnothera* and other Onagraceous genera is usually described in taxonomic works as a "calyx-tube." In one of my hybrid *Œnotheras* a complete series of transitional stages was presented, connecting the normal type of flower, sessile with a long hypanthium, with pedicellate flowers wholly lacking a hypanthium. This indicates that the hypanthium is of cauline nature.

The Morphology and Systematic Position of Podomitrium: D. H. Campbell.

The genus *Podomitrium* comprises two species, *P. phyllanthus* from the Australasian region, and *P. Malaccense,* which has hitherto been reported only from Singapore and New Caledonia. The writer collected the latter species in Borneo and the Philippines.

Podomitrium malaccense closely resembles in appearance a *Blythia,* and sterile plants are indistinguishable. The position of the reproductive organs of the former, in special ventral branches, at once distinguishes it from *Blythia.*

The anatomy of the thallus, as well as the form of the apical cell, is practically identical in *Podomitrium* and *Blythia.*

The antheridia in *Podomitrium* are borne on special ventral shoots. In structure, and in the scales covering them, they most nearly resemble *Mörkia* or *Calycularia.*

The archegonia are also borne in special shoots. The archegonial receptacle is very much like that of *Blythia.* The embryo is much like that of *Blythia* or *Symphyogyna,* but the basal appendage (haustorium) is somewhat less developed.

The fully developed sporophyli closely resembles that of *Blythia,* from which it differs in the more clearly marked foot, and in the presence of a overwell developed apical elaterophore. The spores, in size and surface sculpturing, are hardly distinguishable from *Blythia radiculosa.*

On the whole, *Podomitrium* seems to be more nearly related to *Blythia* than to *Metzgeria,* with which it is usually associated. This study of *Podomitrium* confirms the view that there is no certain distinction to be drawn between the families Aneuraceæ and Blythiaceæ.

Fiber Measurement Studies; Length Variations: Where They Occur and Their Relation to the Strength and Uses of Wood: ELOISE GERRY.

I. The results of the study of *one white pine* tree indicate: (These are based on the measurements made on 6,600 fibers from 66 specimens.)

1. The length of fibers varies with their position in the tree.

A. In (1) a disk from the butt (age 250 years, distance above the ground approximately two feet) and in (2) a disk near the top (about 82 feet above the ground) *the shortest fibers were found near the pith.* An increase in length was apparent from the center outward. This was somewhat irregular (slides). No constant fiber length was attained.

B. In 26 bolts, taken at about 2½ to 3 inches from the pith, at 4-foot intervals between the butt and the top of the tree, a tendency toward an increase in average fiber length was apparent for about two thirds of the height of the tree.

2. *The relation between the fiber length and the strength values of the wood was indeterminate; no direct effect dependent on length alone could be found.* The following indications were obtained, however:

A. From butt to top the S. G. and strength decreased but the average fiber length increased.

B. In some loblolly pine the late wood was about twice as strong as the early wood; the relative fiber length was as 2.69 is to 3.03 mm.

C. In Rotholz the fibers are also stronger (in compression) and shorter than those in normal wood.

That is, the shortest but at the same time the thickest-walled fibers were present in the strongest specimens.

II. The general range of variation in fiber length was not found to be greater within the species than in the individual tree.

1. Longleaf pine (*Pinus palustris*) (1,700 measurements of 15 specimens).

2. Douglas fir (*Pseudotsuga taxifolia*) (900 measurements of 5 specimens).

The longest fibers were found in the earliest springwood; the length then decreased gradually and the shortest fibers were present in the last formed layers of the ring.

III. Certain general relationships also noted:

1. The root fibers of longleaf pine and white pine were found to have a fiber length as long as or even longer than that of the trunk fibers. This may enable the pulp mill to utilize stumps obtained where land is being cleared or the chips from which resin has been extracted for a strong craft pulp.

2. In general the hardwoods or angiosperms have a shorter fiber than the softwoods or gymnosperms. All other things being equal, the strength of a pulp varies with the length of the fibers composing it.

3. The early or springwood fibers are always longer than the late or summerwood fibers. The data obtained from about 80 specimens indicated that less than one fourth of the fibers found in every hundred macerated fibers were summerwood. In two cases the summerwood fibers made up about one third of this amount; in both cases this large number of fibers was found in wood from very low down in the tree. The per cent. and character of the summerwood fibers are significant factors in determining the character of a wood to be used for pulp.

Changes in the Fruit Type of Angiosperms Coincident with the Development of the Herbaceous Habit: E. W. SINNOTT AND I. W. BAILEY.

Angiosperms with fleshy fruits are almost invariably trees, shrubs or climbing herbs. Terrestrial herbs practically always have dry fruits. Herbs seem to have been developed from woody plants in relatively recent times. It is therefore evident that with this change in habit there must have been changes in many families from a fleshy type of fruit to a dry one. This is apparently due to the fact that most frugiverous birds are reluctant to feed on the ground and that herbs have consequently been obliged to develop new methods for seed dispersal.

Some Effects of the Brown-rot Fungus upon the Composition of the Peach: LON A. HAWKINS.

This paper describes the results of several series of experiments on the effect of the brown-rot fungus upon certain carbon compounds in the peach fruit. In the experiments one half of the peach was inoculated with the fungus, while the other was retained sterile under the same moisture and temperature conditions as a control. At the end of two or three weeks the two portions were analyzed. It was found that in the rotted portion the pentosan content was practically the same as in the sound half; the acid content was increased; the amount of alcohol-insoluble substance which reduces Fehling's solution when hydrolyzed with dilute HCl was decreased; the total sugar content was decreased, while the cane sugar practically disappeared.

Senile Changes in the Leaves of Vitis vulpina and Certain other Perennial Plants: H. M. Benedict.

It has been found by an investigation extending through a period of seven years that in the leaves of *V. vulpina* and other plants there occurs evidence of senility. Similarly aged leaves of differently aged plants (age being reckoned from date of last reproduction from seed) show marked differences in the extent of veinage. The aggregates of mesophyll cells enclosed within the smallest veinlets, which may be termed vein-islets, are uniformly smaller in leaves of old plants than in leaves of young plants. In other words, leaves of old plants have a higher percentage of vascular tissue than leaves of young plants; consequently they are less efficient photosynthesizing organs, and this has been proved by experiment. A formula is presented showing the method for determining age of *Vitis vulpina* from the character of its veinage. The juvenile veinage is restored only after sexual reproduction. Finally, a theory of sexuality is proposed, based upon loss in permeability.

Influence of Certain Salts on Nodule Production in Vetch: Mr. Kno.

Calcium salts are essential for nodule production in vetch. The substitution of borium or strontium to a limited degree permits also of nodule development. The relation of balanced solution to nodule production has also been investigated.

Physiological Studies of Bacillus Radicicola of Soy Bean: J. K. Wilson.

This investigation confirms earlier work as regards the influence of nitrates on nodule production, and indicates in addition that sulfates in relatively weak concentration inhibit the process. Chlorides and phosphates stimulate nodule production, while ammonium salts are inhibitory. The significant fact was developed that while nodule development was prevented by the presence of nitrates, phosphates and ammonium salts, yet the organism retained its vitality in the presence of these salts. Whether the effect of the salt is upon the root, such as to make it resistant, or upon the organism can not yet be stated.

Direct Absorption and Assimilation of Carbohydrates by Green Plants: Lewis Knudson.

Confirming and extending the work of Laurent, Molliard and others, it has been found that a variety of plants are able to absorb and assimilate various sugars, including lactose. Plants employed are timothy, vetch, onion, radish, pea, cabbage, clover, flax and corn. Lactose has been found to be utilized by vetch, radish and onion but not by timothy. For corn the sugars in order of "preference" by the plant are glucose, levulose, cane sugar and maltose; for vetch, cane sugar, glucose, maltose and lactose. Experiments on the influence of concentration of the sugar on growth, influence of sugars in respiration and color production have also been made. A study of the influence of sugars in enzyme production is now progressing.

A Preliminary Study of the Chlorophyll Compounds of the Peach Leaf: Howard S. Reed and H. S. Stahl.

The investigations were undertaken with especial reference to the foliage of peach trees having "yellows." The chlorophyll compounds were extracted and separated by the use of inactive solvents. The diseased leaves differ from the healthy in both the quality and quantity of chlorophyll derivatives extracted. The derivatives have been identified by their color, solubility, spectra and other properties.

Among others, the following derivatives have been found in healthy peach leaves: chlorophyll *a*, chlorophyll *b*, phytorhodin, chlorophyllin, phæophytin, phæophorbide, methyl-phæophorbide, methychlorophyllid, phytochlorin, carotin and xanthophyll.

As the disease advances there is a decrease in the quantity of both chlorophyll and chlorophyll derivatives. The diminution of the green series is greater than that of the yellow-brown series.

Respiration in Apple Leaves Infected with Gymnosporangium: Howard S. Reed and C. H. Crabill.

The respiration of apple leaves has been studied with reference to the pathological effects of infection. Foliage was studied at various stages in the development of the disease, using both Ganong's respirometer and Sach's baryta methods. The diseased leaves uniformly produce more carbon-dioxide than healthy leaves in the same intervals. Various factors influence the process.

The Absorption and Excretion of Electrolytes by Lupinus albus in Dilute Simple Solutions of Nutrient Salts: R. H. True and H. H. Bartlett.[1]

[1] Office of Plant Physiological and Fermentation Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

The behavior of seedlings of *Lupinus albus* toward distilled water and toward simple solutions of salts containing ions regarded as essential to the normal nutrition of higher green plants was studied by the water culture method, the plants being kept in darkness. The stronger concentrations employed were comparable with the soil solution under conditions found in the vicinity of Washington, D. C. The absorption of ions from the solutions and the loss of ions to the solution were measured by the Wheatstone bridge in terms of change of electrical conductivity.

The plants give up their salts to distilled water at a variable rate until death ensues from exhaustion. Solutions of KH_2PO_4 and KCl act essentially like distilled water.

In K_2SO_4 and KNO_3 a slight absorption phase is seen in the most favorable concentrations resulting in a minimal net gain in electrolytes to the plant. Otherwise the results differ little from those seen in the phosphate and chlorid solutions. Sodium chloride affects permeability and growth essentially like KNO_3 and K_2SO_4.

In the most favorable concentrations, of $Mg(NO_3)_2$ and $MgSO_4$ there is a slight but clearly developed absorption phase resulting in a net gain of electrolytes to the plant. A net loss takes place in the more dilute solutions and in the greater concentrations toxic action develops.

In $Ca(NO_3)_2$ and $CaSO_4$ solutions all concentrations studied support an active absorption of electrolytes and apparently enable the plants not only to retain the salts already present, but also to make net gains from the solutions.

The Absorption and Excretion of Electrolytes by Lupinus albus in Dilute Solutions Containing Mixtures of Nutrient Salts: R. H. TRUE AND HARLEY HARRIS BARTLETT.

Seedlings of *Lupinus albus* were grown in darkness in graded solutions of pairs of nutrient salts, the higher concentrations being comparable with the soil solution. Absorption or excretion of electrolytes by the roots was measured as changes of electrical conductivity.

The results obtained show that the gain or loss of electrolytes by the plants is in cases influenced by the antagonistic action of ions.

The Transpiration Rate on Clear Days as Modified by the Daily Change in Environmental Factors: LYMAN J. BRIGGS AND H. L. SHANTZ.

The transpiration of a number of crop plants has been measured by means of automatic balances at Akron, Colorado, during the past three years. Automatic records have also been secured of the evaporation from a freely exposed water surface, the depression of the wet bulb, the intensity of the solar radiation, the air temperature and the wind velocity. The present paper compares the results of such measurements for clear days. The transpiration curves are based on a large number of measurements, and expose the normal behavior of these plants on clear days.

Relation of Transpiration to the Composition of White Pine Seedlings: GEORGE P. BURNS.

The experiments reported at the Atlanta meeting were repeated during the summer of 1914, with the addition of two beds in which the physical conditions were changed by means of one and two covers of cheesecloth. The seedlings were grown in five beds each with a different rate of transpiration.

Seeds were sown in May and the first analysis was made of seedlings gathered August 11. This analysis showed the following amounts of protein and soluble ash:

Seedlings	Protein, Per Cent.	Soluble Ash, Per Cent.
No shade	13.88	4.13
Half shade	16.44	4.41
Full shade	36.82	6.46
One cheesecloth	11.56	4.14
Two cheesecloth	12.31	4.15

This table again shows the high percentage of ash in the full shade bed where the rate of transpiration was very low.

A New Method in Lichen Taxonomy: BRUCE FINK.

The results of investigation of the Collemaceæ will be presented. The plants will be treated as fungi and a new type of lichen diagnosis will be presented. This will treat the anatomical characters of the lichen to the exclusion of those features of the algal host which have heretofore been included in the descriptions of these lichens. The characters of the cortices and medullæ have been carefully investigated, and several features will be presented which are new to lichen taxonomy. The sex organs have for the first time been studied with a view to ascertaining their value as diagnostic characters. Camera lucida drawings of cortices, medullæ, apothecia, procarps and spermagonia will be shown, and their taxonomic value will be discussed.

The Mechanism for Discharging the Eggs of Dictyota Dichotoma: W. D. HOYT.

The young eggs of *Dictyota dichotoma* are enclosed by thin walls showing no differentiation,

but as they mature their walls thicken and become differentiated into a thick inner and a thin outer layer. At the instant of discharge the inner layer swells and becomes gelatinous, the outer layer is irregularly ruptured, and the egg is forced through the opening, thus formed, sometimes to a distance of 0.24 mm. In escaping the egg is still enclosed by the gelatinous inner layer, but is soon set free by the solution of this layer.

The observed facts indicate that the force utilized in discharging the eggs is obtained solely by the swelling of the inner layer with the contraction of the stretched outer layer of the oogonium wall.

Both at Beaufort, N. C., and at Naples, about 65–75 per cent. of all the eggs of each crop were discharged within a single hour of a single day, beginning at about the time of the first observable traces of dawn.

The swelling of the inner layer of the oogonial wall, with the resultant discharge, did not occur in eggs that were killed by heat, cold or chemicals, and was practically or entirely prevented by anything that interfered with the life conditions. It could not be initiated by any means before the usual time for discharge, but, as the usual time approached, seemed slightly accelerated by transfer from a moist dish to sea water.

The above facts seem to indicate that the swelling of the inner layer of the oogonial wall is under the direct control of the protoplasm, or that it is accomplished by means of enzymes formed by the protoplasm and affected by the same conditions that affect the living substance. Of these two possibilities, the latter seems more probable.

Cell Division and the Formation of Colonies of Volvox: R. A. Harper.

The planes of the first two divisions of the mother cell of the young colony intersect at right angles. The plane of the third division lies so as to form the well-known cross figure. The factors determining this deviation from Sach's principle of rectangular intersection are associated with the surface tension developed in a plate made by successive bipartition of cells, and lead to the further incurving of the plate and formation of the globular colony.

Prochromosomes in Synapsis: C. A. Darling.

The work on prochromosomes by Rosenberg, Overton and others has suggested the possibility that some cells might be found the study of which would considerably increase our knowledge concerning the behavior of the chromosomes in synapsis and reduction. Such cells have been found in the Norway Maple *Acer platanoides.*

In the so-called resting stage of the nucleus of the pollen mother cell in this species are 26 definite bodies corresponding in number to the 26 chromosomes found in the vegetative cells at the time of division; most of these bodies, or prochromosomes, are distributed about the periphery of the nucleus, but a few are to be found lying close to or against the nucleus. Upon staining with safranin, gentian-violet and Orange G., these 26 prochromosomes are stained blue and the nucleolus red, so that the two are readily distinguished. At this stage the linin threads take the stain only sparingly. At least some of these threads appear to be attached to the prochromosomes; in some cases the threads are connected, forming a sort of net with nodes or thickenings; these nodes do not take the gentian-violet stain and are not definite bodies like the prochromosomes.

The prochromosomes are noticeably arranged in pairs; in some cases the two are separated by at least twice their own width, while in other pairs they almost touch each other; in no case do they appear to be connected. The prochromosomes vary somewhat in size, but so far as observations go the individuals of a pair appear to be equal.

As the period of synapsis approaches, the threads become more conspicuous and take the gentian-violet stain more readily; the prochromosomes still retaining their definite individuality appear to come closer together. The beginning of synapsis is indicated by the contents of the nucleus being drawn toward the nucleolus and collecting at one side of the nuclear cavity. The whole network of threads and prochromosomes becomes more or less massed; only in rare cases do any of the threads appear to lie parallel.

In complete synapsis only a few threads are distinguishable, especially those extending out from the synaptic knot. The prochromosomes, however, are still very apparent; in most pairs the members appear to be in contact with each other, although some are still separated. As growth proceeds the threads which extend outside of the knot become thicker and contain more chromatin, as shown by their staining reaction. These threads soon become double, the evidence indicating that this is due to a longitudinal splitting of a single thread rather than to the parallel arrangement of two separate threads. Apparently each of these thick threads is formed by the gradual flowing out of the contents of the prochromo-

somes on the thin threads to which they were attached before synapsis began, the contents of the two individuals of a pair flowing in opposite directions.

As the growth period advances these threads enlarge, become less entangled, and the splitting becomes more apparent. At this stage deeper staining bodies of different sizes are found distributed on the threads; these bodies, possibly chromomeres, are always found in pairs, one on each of the two parts of the double thread. There are usually 3 or 4 pairs of these chromomeres on each of the bivalent threads, the individuals of each pair being opposite each other and equal in size. As these bivalent threads become less entangled the number of the threads is found to be 13, one half the number of prochromosomes observed before synapsis. The details from this stage on have not as yet been worked out, but observations indicate that each of these 13 threads becomes shorter and finally forms a bivalent chromosome.

In the first division of the nucleus 13 chromosomes pass to each pole; in the reconstructed daughter nucleus 13 prochromosomes appear, but these are not arranged in pairs. In the resting nuclei of the somatic tissue the prochromosomes are present and appear to be more or less in pairs.

These observations seem to show that in *Acer platanoides* prochromosomes exist in the nucleus; that they are arranged more or less in pairs in both somatic and mother cells; that in synapsis the members of each pair unite and form a thick thread on the single thread which preceded synapsis; that this single thick thread becomes split longitudinally; that upon this bivalent thread occur paired chromomeres; and finally that each bivalent thread becomes a bivalent chromosome which divides into univalent chromosomes in the first division of the pollen mother cell.

Cytology of Sphæroplea: E. M. GILBERT.

Cleavage begins with constrictions from the plasma membrane, and the cell contents are cut into masses of varying sizes. A single row of large cells or a double row of smaller cells may be found in a single filament.

All eggs at first contain more than a single nucleus, and all but one of these disappears before the egg is fully mature.

Nuclear divisions as far as observed are mitotic and no indications of amitotic divisions, described by earlier investigators, have been found. There is no fragmentation of the nucleole to form the chromosomes.

The number of pyrenoids found in eggs varies from two to seven.

The pyrenoids vary greatly in size and each is made up of a varying number of segments. The starch is usually laid down around the pyrenoid in definite layers but at times the arrangement is very irregular. Stromatic starch is very abundant in some mature eggs.

The pyrenoids disappear from portions of filament which are active in the formation of sperms.

Fertilization does not take place until the egg is fully formed and rounded; at this time the egg nucleus lies in the center of the egg.

An Anatomical Study of the Root of Ipomœa batatas: FLORENCE A. MCCORMICK.

A preliminary paper on the anatomy of *Ipomœa batatas*. During the investigation, a fungus, similar to the one found in *Solanum tuberosum* has been found in the endodermis of the root, but so far the fungus has not been seen in the stem.

The Anatomy of a Protomyces Gall: ALBAN STEWART.

The lower parts of the stems of *Ambrosia trifida* L. are often attacked by *Protomyces andinus* Lagh, causing considerable disturbance in the tissues of the host. Large swellings are caused by this parasite, one or more of which may appear on the same plant.

Sections of these galls show, among other things, an increase in the tissues of the bark, an abnormal growth of the fibrovascular bundles as compared with non-infected parts close by, a broadening of the rays and the formation of other parenchyma elements in the bundles, areas of cambiform cells in the pith.

A gall caused by an unknown insect, probably of the order Lepidoptera, also occurs on the stems of this species of *Ambrosia*. The changes induced by this insect in the tissues of the host are similar in certain respects to those caused by Protomyces.

The Anatomy of the Punctatus Gall: ALBAN STEWART.

Andricus punctatus Bass., a hymenopterous insect of the family Cynipidæ, causes large woody galls on the stems and branches of *Quercus velutina* Lam. and other closely related species of oak. This gall possesses, among others, the following anatomical characters which are of especial interest.

A recapitulation of a similar condition of ray structure to that which occurs in traumatic wood

of related species of oak. Other characters which agree closely with general conditions in traumatic tissue are as follows: A vertical shortening of the broad rays. The presence of knarls which appear only in tangential sections of the gall. A parting of the fibers to right and left in the vicinity of the larval chambers. Areas of isodiametric parenchyma cells with lignified walls, and a shortening of many of the other cells of the wood. A reduction in the number or an entire lack of vessels. Absence of distinct annual rings of growth. A suggestion of a return of the cambium to its normal activities in the outermost layers of wood. Woody inclusions in the bark.

The Anatomy of a Peridermium Gall: Alban Stewart.

Large woody galls occur on the branches of the jack pine, *Pinus Banksiana* Lamb., which are caused by an infection of *Peridermium* (*Aecidium*) *cerebrum* Pk. The following anatomical differences occur in the woody portions of these galls as compared with the normal wood of this species of pine. A greatly increased production of woody tissue. An increase in the number, and a broadening of the rays both vertically and tangentially, characters which also appear in traumatic wood of this species. The presence of knarls in tangential sections. A greatly increased production of resin canals in the gall, but no such increase in the normal wood close by. A shortening of many of the tracheids as well as blunt end walls and wavy side walls of the same. Cells which partake of the character of both tracheids and parenchyma cells in their pitting. Alternate as well as opposite arrangement of pits in the walls of the tracheids. Apparently an absence of bars of *Sanio* from the walls of the tracheids in many instances.

A Note on the Leaf Anatomy of Avicennia: Alban Stewart.

On the Forms of Castela galapageia Hook. f.: Alban Stewart.

Photographing Mosses: A. J. Grout.

When beginning the study of mosses I found identifications very difficult because of the lack of suitable and adequate literature and illustrations. I did not have access to Sullivant's "Icones" or the "Bryologia Europæa."

When as an advanced student I had access to these works I formed the ambition to put similar but cheap and simplified books within the reach of any enterprising student. My desire was to make new moss students instead of new moss species, because what we need to advance bryology in America is, first of all, more observers and collectors.

The two books I have published were illustrated by drawings, many of which were taken from the standard works mentioned above. But I saw how valuable photographs were in the study of flowers, ferns, etc., and I became ambitious to equal this work in the mosses and hepatics. To this end I have devoted my spare time for the past year or two, and I have succeeded in enlisting others. Professor Holzinger has done some excellent work.

My outfit is a Bausch and Lomb camera for micro-photography with a heavy iron base and long bellows. Instead of the cap to fit over the eye-piece of the compound microscope I put in a lens-board or boards. I have a battery of three lenses, a Wollensack Anastigmatic F. 6.8 for a 4 by 5 camera and a supplementery lens to shorten the focus. A Beck Neostigmar 3 in focus, f. 3.5, wide angle from a motion-picture camera and a Bausch and Lomb wide angle Zeiss-protar, focal length 2¾ inches.

The Wollensack and supplement give magnifications up to 5 diameters, and the automatic shutter makes it more convenient than the others, which have to be uncapped. Also it gives plenty of illumination for focusing. The Beck gives magnifications up to 7 diameters and also admits plenty of light for focusing. The Zeiss protar is so small that focusing is difficult unless bright sunlight shines on the object, but I can get 9 diameters. To get depth the lenses were stopped down to 32, 64 or even to 128 U. S., and in strong light were given from 3 min. at 32 U. S. to 6–8 min. at U. S. 64 when cloudy bright and indoors.

If the mosses were not dry the setae would sometimes twist during the longer exposures so as to produce a bad blur. I have had better results with reflected light than transmitted light. I am undecided as to whether a black background is superior to a white or not. Against the black background every speck of dust magnified tenfold produces a disagreeable effect.

I have also tried peristomes by transmitted light under a compound microscope. I squandered more than a dozen plates on the peristome of *Ceratodon*, but its dark red color and density foiled my attempts to get anything but a silhouette.

The photographs themselves will tell you far more than I can as to my results.

George T. Moore,
Secretary